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Technology based learning and quality in Australian universities

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**TECHNOLOGY BASED LEARNING and
QUALITY in AUSTRALIAN UNIVERSITIES**

A thesis submitted in
partial fulfilment of the degree
Master of Education (Honours)

from
University of Wollongong

by

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B.Sc.(Hons), Ph.D. (University of Melbourne)

Faculty of Education
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1996

In Australian higher education 'quality' is the word of the 1990s.

The Hon P.J. Baldwin, Minister for Higher Education and Employment Services.

February 1993

(Baldwin 1993)

*Throughout the Western World the issue of quality in
higher education is the flavour of, perhaps, the decade.*

Committee for Quality Assurance in Higher Education.

Report on 1993 Quality Reviews.

(CQAHE 1994).

*Innovation was often interpreted by universities to mean
the application of educational technology.*

Committee for Quality Assurance in Higher Education.

Report on 1994 Quality Reviews, Volume 1

(CQAHE 1995)

For all my family
with much love and with thanks.

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Finally, many thanks to Terena who introduced me to the concepts of Total Quality Management with a spontaneous tutorial on the topic. She has been there for me during the many stages of this thesis – as a sounding board for ideas, and as a friend during the crises, and in the days of inspiration. We have both learnt a lot about the Australian higher education sector during the preparation of this thesis!

Abstract

The introduction of 'quality' practices and of information technology in teaching to the tertiary system have each been initiatives in Australian universities in the early to mid-1990s. The Department of Employment, Education and Training (DEET) supported these changes to the Australian tertiary system through the Committee for Quality Assurance in Higher Education (CQAHE) and through the Committee for the Advancement of University Teaching (CAUT). Through the CQAHE 'Quality' money was made available to universities that could show that they had quality assurance/Total Quality Management practices in place. CAUT offered small grants to university teachers to promote innovations in university teaching. These CAUT National Teaching Development Grants were not specifically for developing information technology-based materials (although the committee was initially established with a specific role in disseminating information about best practices of the use of information technology in higher education), but a large proportion (about two thirds) of successful grant applications had the aim of developing computer aided learning materials or were technology-based. The guide to applicants in the first years the grants were offered also perhaps implied a bias toward information technology based projects.

These two initiatives of DEET, the prime funding body of Australian universities, have each had many millions of dollars spent on them. This thesis will look at two themes, (i) the introduction of the business concept of 'Quality' into Australian universities and (ii) the introduction of information technology into undergraduate teaching, and investigate if they have been combined to lead to enhanced Quality educational experiences for undergraduates at Australian universities.

As with any learning materials, technology based learning (TBL) materials may take an instructivist or a constructivist approach. It is suggested that at a tertiary level where the learner is at an advanced stage of knowledge acquisition and is developing higher order thinking skills that a constructivist approach is more suitable. Thus

innovations in teaching at a tertiary level should have a constructivist approach rather than the traditional instructivist approach of lectures and (many) tutorials.

This thesis proposes that in isolation most information technology-based materials will not be successful in enhancing the quality of education, and that for IT-based learning materials to be of use to undergraduate education a culture change to one of Total Quality Education is needed. IT-based learning materials alone cannot deliver Total Quality Education to students. However, with a culture change of both university staff and students to one where the students take responsibility for their own learning and the teacher becomes a resource, a facilitator, and mentor for the learning then the IT-based learning materials may facilitate overcoming the difficulties faced by all Australian universities in times of decreasing funding and increasing student numbers. It is proposed that through technology-supported problem based learning the quality of both the educational experience of students and the quality of graduates will be enhanced.

Through the activities of the Committee for Quality Assurance in Higher Education and the Committee for Advancement of University Teaching the issues of Quality and those relating to teaching and the roles technology may play in university teaching have been raised in of Australian universities. This has prepared Australian universities to take advantage of the ever increasing opportunities being offered by technology in education in the coming decade. Whether these opportunities are grasped in the coming decade will, of course, be influenced by the goals of the current federal government have for Australian universities.

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ACRONYMS AND ABBREVIATIONS

CAUT	Committee for the Advancement of University Teaching
CAL	Computer Aided Learning
CQAHE	Committee for Quality Assurance in Higher Education
CUTSD	Committee for University Teaching and Staff Development
DEET	Department of Employment, Education and Training
DEETYA	Department of Employment, Education, Training and Youth Affairs
EFTSU	Equivalent Full Time Student Units
HEC	Higher Education Council of the National Board of Employment, Education and Training
IT	Information technology
NBEET	National Board of Employment, Education and Training
NT	New technology/technologies
NTDG	National Teaching Development Grant
TBL	Technology Based Learning
TQM	Total Quality Management
TQE	Total Quality Education
UNS	Unified National System

CHAPTER 1 INTRODUCTION

'Quality' money and Australian universities

In October 1991 'quality' was set squarely at the top of the agenda of Australian universities, the reason was simple enough: *Funding*. The situation was summed up by the then Minister for Higher Education and Employment Services the Honourable Peter Baldwin:

The approach to quality assurance envisaged by the Government involves the formation of a national structure, independent of the Government, to report and comment on the application and effectiveness of quality enhancement measures developed by the institutions.... It balances institutional autonomy with public accountability. It is based primarily on self assessment by institutions rather than on relying on external assessments of quality.

(Section 4.26, p34 Baldwin 1991)

The extra funding offered to universities in the Unified National System was for 'good performance' (Baldwin 1991), specific elements of 'good performance' identified in the Minister's statement are: quality management practices; the composition of the student population, and; articulation and credit transfers.

University funding had decreased in real terms on a per student basis between 1983 and 1991 – during this period there had been a decline of 11.2 per cent of dollars per Equivalent Full Time Student Unit (EFTSU). Although during the period 1983-94, there was a rise of over 50 per cent in the total expenditures on higher education, student enrolments had also sharply increased (Mahony 1994). Thus any additional funds to universities were greatly needed.

Committee for Quality Assurance in Higher Education

Australian universities in the 'Unified National System' receive most of their funding from the federal government – this includes their recurrent and capital funds, as well as research funding. Australian universities are thus financially dependent on the

federal government. As an outcome of Peter Baldwin's 1991 statement in 1993 the federal government offered Australian universities a chance to share in \$76 million allocated by the Committee for Quality Assurance in Higher Education (CQAHE) for indications of quality in the University sector (or rather for the quality of quality assurance programs in place). This was followed in 1994 with an offer of \$80 million in additional funding to universities in the Unified National System (Hadgraft and Holecek 1994) and a similar amount in 1995. These funds are equivalent to about two per cent of university operating grants annually - a substantial amount of funding indeed.

Offering tens of millions of dollars in extra funding to those universities that could demonstrate the implementation of 'quality' practices was a way for the Australian government to increase the accountability and competitive mechanisms that ensure institutional efficiency and practical consciousness of government goals (Mahony 1994). The government did not impose performance indicators on the universities, rather individual institutions had to determine their own performance indicators, defend them, and have them available for institutional comparisons (Mahony 1994). Participation in the program by the universities was entirely voluntary - but not participating in the program eliminated any chance of a share of the \$70 to 80 million available per annum through the program. The funding of the program was clearly very attractive to universities, in addition to the prestige associated with it. The use of this type of 'incentive funding' is a device which avoids direct government intervention in university governance while still indirectly setting the desired agenda. The less necessary the additional funds for an institution's ongoing well-being, the less of an intrusion into university management are any requirements of such incentive funds.

The federal government was therefore not providing extra funding for those universities producing high quality graduates or high quality research, but rather the funding was for universities that could demonstrate quality enhancement measures in place. An extensive work on the field is the report to the Department of Employment,

Education and Training by David Piper (Piper 1993) which outlines procedures of assessing 'quality' programs at universities.

Committee for the Advancement of University Teaching

Also in Baldwin's 1991 paper *Higher Education: Quality and Diversity in the 1990s* (Baldwin 1991) which addressed the issues of enhancing the quality of Australian universities was a section on a 'more flexible system' where new technologies and their potential to impact on the quality of university teaching is emphasised.

*The Government aims to promote developments in this area
...which take full advantage of developments in information
technology ...Initiatives will include:*

- ...
- *funding a National Centre for Teaching Excellence (as outlined in paragraph 1.12), part of the function of which will be to disseminate information on best practice in this area.*

(Section 1.28, p 7, Baldwin 1991)

This 'National Centre for Teaching Excellence' came into existence as the Committee for the Advancement of University Teaching (CAUT) as a ministerial committee in 1992 with a brief to raise the status and quality of university teaching. Thus the link between enhancing the quality of Australian universities and the use of information technologies in teaching and learning at Australian universities was explicitly made in the paper from which the CQAHE and CAUT were born.

The Committee for the Advancement of University Teaching's mission was to assist change in the culture of Australian higher education so that teaching is restored to its central position in academic culture (CAUT 1993b). The main program of the CAUT is that of the National Teaching Development Grants, this program is allocated 80% of CAUT funds. The aim of this grant program was to "improve the quality of teaching by supporting teaching development projects which lead to practical improvements in teaching, learning and assessment" (CAUT 1995a) and for projects "in

the area of innovation in teaching and learning” (CQAHE 1995) and were awarded annually by CAUT on a competitive basis from 1993-1996. The grants were not specifically for development of materials to be used with new technologies, though, as will be shown, there was a strong perception that Information Technology (IT) based projects were favoured.

Thesis outline

This thesis will explore ‘Quality’ in Australian universities in the 1990s, how it is linked to using technology in university teaching, and whether CAUT grant recipients achieved it in their products. The early chapters will look at what ‘Quality’ is and its development as a business, then educational, concept and how technology based learning has been supported by the Australian federal government’s Department of Employment, Education and Training (DEET) through ‘quality’ money allocated by the CQAHE and through CAUT. The latter part of the thesis looks at how a piece of quality TBL material should be developed (‘best practice’) and then investigates how a number of CAUT National Teaching Development Grant recipients went about the development of their products and whether they followed the best practices available at that time. The thesis concludes that, although the CAUT could have supported grant recipients through giving them greater guidance on these best practices for developing TBL materials, through the actions of the CQAHE and CAUT Australian universities are well placed to take advantages of developments in information technology in the next decade.

Chapter 2 looks at the history of the ‘Quality’ movement from its roots in the manufacturing industry to Total Quality Management (TQM) which is now implemented in organisations of all kinds worldwide. The concept of Total Quality Education (TQE), which is an extension of TQM, is discussed. Chapter 3 explores how and why the concepts of ‘Quality’ were introduced into the Australian higher education sector and at changes in the Australian university sector in the late 1980s and early 1990s. These changes include the outcomes of the 1988 White Paper *Higher Education:*

A Policy Statement (Dawkins 1988) which led to major structural changes in Australian universities and the 1991 policy statement *Higher Education: Quality and Diversity in the 1990s* (Baldwin 1991). It was this statement that put 'Quality' on the agenda of all Australian universities and was the basis of the establishment of the Committee for Quality Assurance in Higher Education (CQAHE) (and thus the 'Quality Money' funding) and the Committee for Advancement of University Teaching (CAUT) (which funded the National Teaching Development Grants). Chapter 4 investigates in greater detail the CQAHE, its establishment, and the basis for the allocation of funds for quality processes in universities. In particular, links between this committee, quality issues and innovations in teaching which were 'most often interpreted by universities to mean the application of educational technologies' (CQAHE 1995) are addressed. Chapter 5 looks at the National Teaching Development Grant scheme administered by CAUT, and in particular at the apparent favouring of technology based projects by the National Teaching Development Grant. This tendency had its roots in the inception of CAUT through Baldwin's 1991 policy statement on quality and Australian universities. Chapter 6 looks at the processes of how TBL materials should be designed and developed and the importance of the development team, the application of learning theories, and effective evaluation of the product. The relationship between TBL and Total Quality Education (TQE) and ways in which TBL and TQE may be fruitfully combined through technology supported problem based learning are also considered and two examples of problem based learning combined with technology based learning within a holistic approach to biological and medical education are presented. In Chapter 7 the results of a survey of CAUT grant recipients on how they undertook their projects developing TBL materials are presented and discussed. Through comparing the best practice (as discussed in Chapter 6) and results of the survey, the likelihood of grant recipients of achieving a quality outcome is investigated. In Chapter 8 some suggestions of how the CAUT may have more effectively supported grant recipients are made and the thesis concludes that although Australian universities may not yet have achieved Quality, and technology is not yet generally being used to enhance the quality

of teaching and learning, through the activities of the CQAHE and CAUT Australian universities are better prepared to take advantage of the advances in technology in the next decade to increase the quality of university education.

CHAPTER 2 'QUALITY' AND TOTAL QUALITY EDUCATION

A Brief History of the 'Quality' movement

The 'Quality Movement' was an export of the USA to Japan in the 1950s - and forty years later the USA is still trying to catch up. The catching up with Japan is largely being done by applying the same methodology of 'quality management' that was ignored in the USA but was taken up by Japanese industry in the 1950s. This section will look briefly at the history of the quality movement, its phases, and how it evolved from application only in manufacturing and the factory floor to an all-pervading approach to organisations of all kinds. It will look at how 'quality' in this sense has been applied to education, leading to the concept of Total Quality Education (TQE).

Inspection Era (pre-1930s)

The quality that had been an assumed trait of the products of artisans was no longer a reality in the era of mass-production following the Industrial Revolution. Rather than an individual crafting an item and taking responsibility for its quality, mass production and production lines removed this responsibility from producers of goods and transferred it to an inspector at the end of the process. The inspector detected defects, accepting some items and rejecting others, thereby ensuring products that left the factory were of a set standard. This era of 'Inspection' was the standard in manufacturing before the 1930s (Seymour 1993, p8).

Statistical Quality Control (1930s-1950s)

In 1931 W.A. Shewhart, a statistician at the Bell Telephone Company, recognised that the variability in industry could be understood using the principles of probability and statistics. Using this understanding Bell Telephone questioned the need to test 100 per cent of its output, and rather than 'inspecting in' quality after a unit had been fully assembled, the idea was to 'control in' quality by using sampling and statistical techniques (Seymour 1993, p9). This 'statistical quality control' was recognised as a discipline and was used in the USA in the 1940s and 1950s. The thrust

of quality control was, however, primarily statistical and narrowly confined to manufacturing.

Quality Assurance (1950s -1980s)

The next era in the history of 'quality' was that of quality assurance. This approach took the aim of quality beyond statistics and the factory floor to a management function. Individuals important in this movement were Joseph Juran (see Juran 1988), Philip Crosby (see Crosby 1984), and W. Edwards Deming (see Deming 1986). Juran (1951) in his *Quality Control Handbook* showed that the entire production chain had an effect on quality. He also explored the planning function and economics of quality. Crosby also helped broaden the scope of the quality movement. Deming was an advocate of Shewhart's work in statistical process control and began his career with the US Department of Agriculture in the 1920s, but it was not until after World War II that his influence had a major impact when in 1950 Deming visited the *Union of Japanese Scientists and Engineers* as a private consultant. In post-war Japan it was a very difficult time economically. Japan had lost much of its traditional markets (China and Manchuria) due to the war and what industrial production there was had a worldwide reputation of shoddiness. This was the era when "Made in Japan" was a synonym for junk (Seymour 1993 p11). How then did Japan turn this around until today "Made in Japan" is a synonym for high quality and very desirable goods?

Deming gave lectures on statistical techniques to Japanese businessmen and his charts and checklists were adopted by technical people. More importantly, his message that 'building in' quality was more than statistical techniques was accepted by the management of most of Japan's largest companies. The Japanese companies were encouraged to adopt a systematic approach to problem-solving and Deming, along with Juran, continued to broaden the message to include consumer research, goal-setting, and organisational issues. The Japanese embraced these approaches and they adopted and innovated them (Seymour 1993, p11).

Strategic Quality Management (1980s-1990s)

In the 1980s the approach that Deming had been preaching (and had been listened to by the Japanese) was finally taken up in the USA and other western nations. America had lost leadership in quality and consumers were turning their backs on US-produced goods and the US economy was suffering. In the 1980s in the USA quality was seen as a leadership function that could be 'managed in' to the daily routine of an organisation for the first time. Quality was included in the strategic planning process and in financial planning - quality was linked to profitability. The understanding of quality was also transformed to consider quality from a customer's point of view, not just an internal standard (Seymour 1993, p11).

Some approaches to Quality

Total Quality Management (TQM)

TQM has as its primary philosophy 'The first priority of an enterprise and everyone in it must be knowing and satisfying the customer' and a number of underlying principles:

- Quality is meeting or exceeding customer needs;
- Quality is continuous improvement;
- Quality is leadership;
- Quality is human resource development;
- Quality is in the system;
- Quality is fear reduction;
- Quality is recognition and reward;
- Quality is teamwork;
- Quality is measurement; and,
- Quality is systematic problem-solving.

(Seymour 1993)

Total Quality Management (TQM) differs from the earlier approaches on quality control and quality assurance. The approach of quality control is one of 'accept or reject' at the end of the production line, while quality assurance takes the further step

of monitoring the production line and through analysis deciding where improvements can be made in sub-processes to reduce the number of defective products. TQM has, as mentioned earlier, its roots firmly in manufacturing but, unlike its predecessors, has been applied to all types of organisations. The approach encompasses all aspects and all members of an organisation. TQM requires a cultural change in an organisation - it cannot be implemented successfully by only some members of an organisation (*e.g.*, the ‘inspectors’ at the end of the production line) or even by teams within an organisation (*e.g.*, a quality assurance group in a business).

ISO Standards: Where do they fit in with the ‘Quality Movement’?

The ISO 9000 (“eye-so nine thousand”) standards are administered by *International Organisation for Standardisation* and their national equivalents, which in Australia is *Standards Australia* and the AS3900 standards (Standards Australia 1987). The *International Organisation for Standardisation* is a worldwide federation of national standards bodies from approximately 100 countries, one from each country. The *International Organisation for Standardisation* was established in 1947 and is a non-government organisation whose mission is to promote the development of standardisation and related activities in the world with a view to facilitating the international exchange of goods and services, and to developing cooperation in the spheres of intellectual, scientific, technological, and economic activity. ISO standards include, for example, paper sizes (ISO 216), the symbols for automobile controls, the size of freight containers, and the safety of wire ropes. These standards allow products to be traded between countries with the assurance of a standard (ISO 1995). ISO 9000 are the standards for quality management and quality assurance. The ISO 9000 core series was first published by ISO in 1987 - since then more than 70 countries have adopted the ISO 9000 series as national standards. The ISO 9000 standards represent an international consensus on the essential features of a quality system to ensure the effective operation of any business, whether a manufacturer or service provider, or other type of organisation, whether public or private (ISO 9000 Forum, 1995). The standard

requires that a basic quality system be implemented to ensure customers that suppliers have the capabilities and systems to provide quality products and/or services (Gardner 1994).

In August 1994 the University of Wolverhampton became the first institution in the United Kingdom (and perhaps the world) to gain ISO 9001 registration for the entire organisation and for the whole of its core business (Storey 1994). An interesting note here is the definition of the 'core business' of a university. It was defined as "the design and delivery of learning experiences with provision for research and consultancy services". This registration followed three years preparation by the institution and a four-day visit by the British Standards Institute.

Some have questioned the application of the ISO 9000 standards where some organisations are choosing to replace or modify their TQM initiatives to meet the ISO 9000 standards (Gardner 1994). Gardner (1994) argues that while ISO 9000 series registration requires the support and involvement of senior management, it is not a transformation initiative. ISO 9000 does not require the transformation of management practices or the substantial commitment of personal time that TQM does. TQM requires that quality is the way business is done by all members of the organisation.

How TQM relates to Higher Education: Total Quality Education (TQE)

In the 1980s industry, both manufacturing and service, embraced the concept of Quality as a philosophy on which to base their enterprise. This is done under a variety of names including Total Quality Management (TQM), Continuous Quality Improvement (CQI), and Quality Improvement Program (QIP). All of these approaches have similar philosophies to that outlined earlier for TQM. In the 1990s the Higher Education sectors in many countries have taken on these management approaches. The question was asked in the late 1980s and early 1990s - 'If quality management works so well in industry, why not in education?'. In response to this, numerous educational institutions implemented quality management and evidence thus far shows that it works well in education. Many Australian universities have taken on these philosophies to

gain the funds made available by the federal government through the Committee for Quality Assurance in Higher Education.

How do we translate industry and manufacturing ideas to higher education?

In translating the TQM approach where an underlying philosophy is 'The first priority of an enterprise and everyone in it must be knowing and satisfying the customer' (Seymour 1993) from manufacturing to education at least two questions spring to mind:

- Who is the customer?
- What is the product?

It must be kept in mind that the university is not a factory and the students are not the product. Universities and other places of education have the difficult task of having a range of customers - schools, the students themselves, their parents, their future employers, recipients of research and services, and the community (Banta 1993, Saunders *et al.* 1994). The 'product' of universities is the education of the students and the findings of the research undertaken. Also, unlike manufacturing, there is no opportunity for 'recalls' to fix any defects in the education process.

A TQM approach can be applied to each of the many spheres of management of a university - its educational programs, research, community service, staff, students, academic support services, and its resources and assets (Piper 1993). For this approach to be successful the university must set goals and standards for its members to work towards. The usual way for this to be articulated is in a mission statement of the enterprise. The mission statement will define the essential elements of the organisation - its purpose, its philosophy, and its form (Piper 1993).

Universities have, on the whole, been producing a 'quality product' for the history of their existence. How then does the 'Quality Movement' have relevance in this system? The research component of university systems has an in-built 'quality assurance' mechanism in that prestige in this sphere is gained through publication of articles in peer-reviewed journals and through competitively gaining grants, which are

also peer-reviewed. This has ensured a high standard of research undertaken in our universities.

The same, however, may not be said of the teaching responsibilities of universities. Until fairly recently teaching responsibilities were not rigorously reviewed or assessed, and excellence (or otherwise) of teaching was not seen as of importance for an academic climbing the promotional ladder. The way teaching was (is) approached was (is), in the terms of the Quality Movement, to a large extent still in the pre-1930s mode of quality control rather than quality assurance or TQM. That is, the students were (are) tested at the end of a subject and deemed acceptable (passed) or rejected (failed). This may be to some extent an overstatement of the situation. as, unlike industry, in the universities there has always been the principle of individual responsibility of courses and their quality (Laurillard 1993).

This approach is being reassessed and, like industry, educational institutions are realising that building and managing quality into the process can be cheaper than simply quality control at the end of a course or subject. In manufacturing terms this recycling of 'rejects' back to the beginning of the production line for another cycle was recognised in the 1930s as uneconomical.

How then is teaching in higher education responding to the Quality Movement? The most apparent way is in getting feedback from students about the courses they are presented with. In Australian universities student reviews are now part of a lecturer's promotion process. This involvement of students in the process of their education is a key part to implementing TQM in universities. As a major part of the university community (students outnumber staff by about 10:1) student input into their education should be considered carefully. Teachers cannot and should not relinquish their responsibility for running classes, but through negotiation with students a better experience for all may be gained. A well documented example in the secondary educational system is in Sitka, Alaska where the teacher spends two weeks discussing and negotiating with students until consensus is gained on what constitutes a quality

experience. It was then observed that, rather than it being a waste of a considerable amount of class time, once the students understood and accepted what it meant to do quality work they learned with such speed and effectiveness that they more than made up the time spent on defining a quality experience (Tribus 1994).

Conclusions

The Total Quality Management of an organisation, if implemented correctly, should lead to both satisfied customers – in the case of the universities students, parents, employers, the community – and a great deal of satisfaction for the staff. Goals that are defined and worked towards as a team often bring great satisfaction to team members, and recognition of the contributions and skills of team members often elicit exceptional contribution from team members. This style of management of a group is just as applicable to the staff of the university - academic, general, and administrative - and the students studying at the university. A TQM approach for a university should enhance experience for both staff and students and lead to satisfaction of future employers and the community with what the university 'produces'. The degree to which TQM in universities is being applied varies between universities, but is increasing.

CHAPTER 3 *HIGHER EDUCATION: QUALITY AND DIVERSITY IN THE 1990s*: IMPLICATIONS OF THE 1991 POLICY STATEMENT FOR AUSTRALIAN UNIVERSITIES

Introduction

The Australian university system today is vastly different to that of 50 years ago, and indeed is considerably different to its form even ten years ago. Over approximately the past fifty years Australian universities have changed from being institutions for the education of an elite group to a system for mass education. In Australia in 1942 only 1.7 persons per thousand attended universities¹ (Ashby 1946) while in 1995 the rate was 148 per thousand (Maling 1995). In addition to, or indeed as a consequence of, the huge increase in the proportion of the population attending universities in Australia there has been a vast increase in the diversity of students attending universities today as compared to fifty years ago, or again, even a decade ago. This increase in diversity of background, ability, and age of students has put pressure on the university system to reconsider its approach to teaching. The traditional methodology of 'chalk and talk' (lectures) supplemented by tutorial classes, and in the sciences, laboratory classes, is not suitable for many students now attending university. Reasons for this include the learning style or background knowledge of the students, or because the style and timing of education being demanded increasingly is one suited to their time and place, that is distance education and flexible learning, that can be suited to a person already well on their career path rather than the traditional student who is in their late teens and a full-time, attending student.

This chapter will look at some of the recent changes to the Australian higher education and its transition over the past decade into one of mass education. The autonomy of institutions of the past is gone and today universities are organised under a

¹ He also noted that there were 3.8 persons per thousand in hospitals for the insane and government spending was four shillings and three pence per head of population on the hospitals and 10 or 11 pence per head on the universities.

national system which is funded and coordinated by the government of the day and the priorities of universities are, to some extent, directed by government incentive funding. The introduction of the concepts of Quality from the business world to that of higher education in Australia through Peter Baldwin's policy statement of 1991 entitled *Higher Education: Quality and Diversity in the 1990s* (Baldwin 1991) are investigated, as are the impacts of this statement on Australian universities.

Australian Universities, Student Numbers, and the Dawkins White Paper of 1988

The Australian university sector has been expanding rapidly throughout most of its relatively brief history (Table 1). This growth has well-outstripped population growth with much of the increase of the proportion of Australians attending university being in the last decade or two (Figure 1).

Year	Australian population	No. of universities	No. of students at university	% of the population at university
1845	250,000	0	0	-
1855	800,000	2	35	0.00%
1875	2,000,000	3	350	0.02%
1905	4,100,000	4	3,300	0.08%
1915	5,000,000	6	6,200	0.12%
1925	6,000,000	6	12,500	0.21%
1945	7,250,000	6	16,500	0.23%
1955	9,300,000	9	30,900	0.33%
1965	11,470,000	14	81,400	0.71%
1975	13,849,300	18	148,338	1.07%
1985	15,580,000	19	175,476	1.13%
1995	17,843,400	36	585,396	3.28%

Table 1 Australian population, number of universities and number of university students 1845 to 1993.

Sources: Data to 1965 from MacMillan 1968; 1975 onwards from Australian Yearbooks (ABS 1978, ABS 1988, ABS 1996).

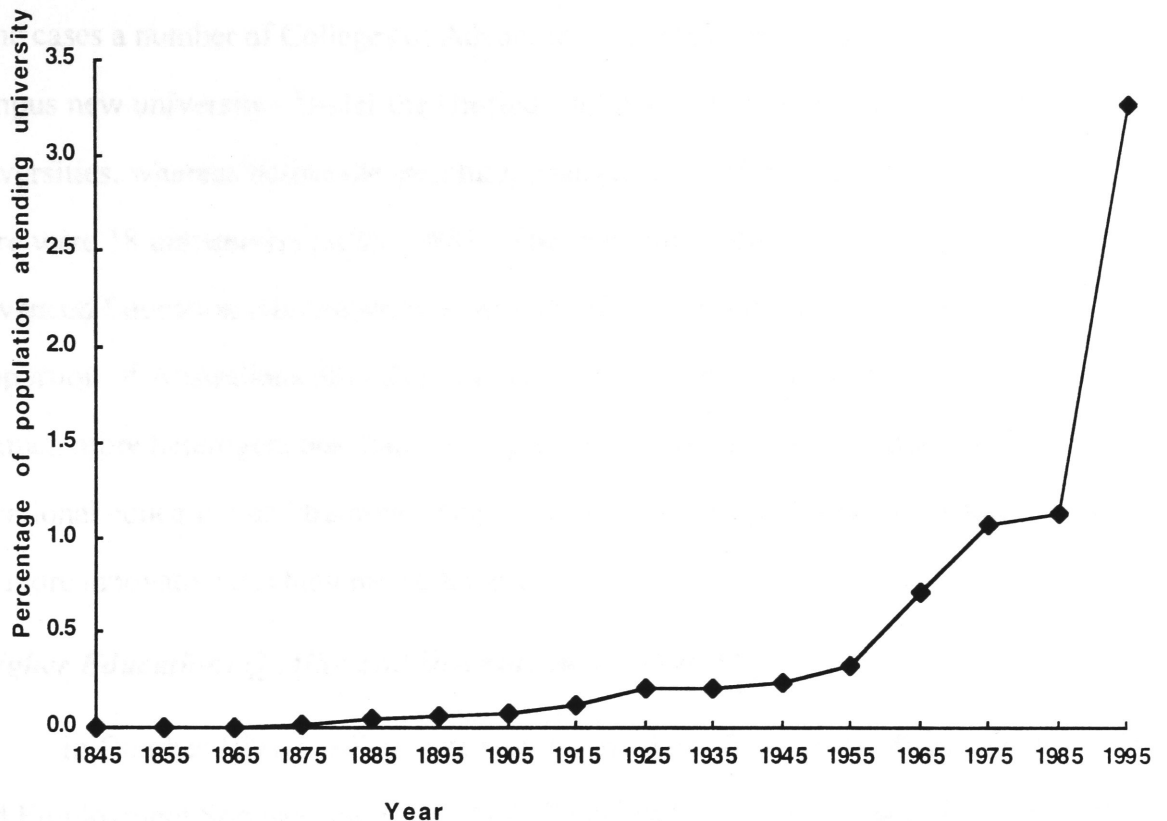


Figure 1 Proportion of the Australian population attending university. 1845 to 1995.

Sources: Data to 1965 from MacMillan 1968; 1975 onwards from Australian Yearbooks (ABS 1978, ABS 1988, ABS 1996).

The Dawkins 1988 White Paper: *Higher Education: A Policy Statement*

After the 1988 government white paper *Higher Education: A Policy Statement* (Dawkins 1988) there was a huge upheaval in the structure of the Australian university system. The outcomes included the ending of the divide between universities and colleges of advanced education, the 'binary system', with the establishment of the 'Unified National System' of Australian higher education in 1989. Research funding was also changed with a greater proportion of research funding being determined by grants from the Australian Research Council (ARC) rather than through each institution's operating grant from the government.

These changes included the amalgamation of institutions into multi-campus universities which were often made up of a 'traditional' university amalgamated with one or more institutions which had previously been Colleges of Advanced Education. In

some cases a number of Colleges of Advanced Education were amalgamated into a multi-campus new university. Under the Unified National System there are now (1996) 37 universities, whereas before the structural changes dictated by the White Paper of 1988 there were 18 universities (ABS 1988). The transformation of the Colleges of Advanced Education into universities was a major contributor to the increased proportion of Australians attending universities by 1995. This new student population is much more heterogeneous than it was previously, with a much greater emphasis on vocational education and training. The needs of some of these students dictate a need for more innovative teaching methodologies.

'Higher Education: Quality and Diversity in the 1990's'

In October 1991 a policy statement by the then Minister for Higher Education and Employment Services, the Honourable Peter Baldwin, was released (Baldwin 1991). This 59 page document entitled *Higher Education: Quality and Diversity in the 1990's* set the scene for further changes in Australian universities for the early to mid-1990s. The statement focussed on quality assurance in the higher education sector, excellence in teaching, participation in the system, and the potential of new technologies in the delivery of education. The statement came soon after the 1988 White Paper on higher education (Dawkins 1988) and it acknowledged the changes that had occurred in Australian universities during the previous three years and did not propose any further major structural changes. In the foreword the aims of the policy statement include:

The statement sets directions for the development of Australia's higher education system through the 1990s as a foundation for our social, economic and cultural developments in the twenty-first century. These directions build upon the achievements of growth with equity in participation that have been realised through the White Paper initiatives. They give priority to quality in diversity as the system responds to emerging challenges

.... The focus of the new policy directions is the development of a comprehensive set of measures to further enhance the quality of higher education teaching and research. I am proud of the fact that

in promoting quality of provision in this way, building upon a fine record of academic performance, Australia is at the forefront in taking action which genuinely seeks to balance university autonomy with public accountability. The Government is taking a lead internationally in providing incentive funding, over and above funding for student load, to promote the best possible quality in higher education.

(Foreword, p v.
Baldwin 1991)

More specifically, there were three broad themes in the statement:

- *the need for credible quality assurance arrangements for Australia's higher education system, and for arrangements to systematically reward excellence in teaching as well as research;*
- *the changing pattern of participation in higher education during the 1990s, and the relationship of higher education to the other education and training sectors; and*
- *the potential for new technologies and alternative delivery modes to transform aspects of the delivery of higher education, and to substantially broaden access. Institutions need increased flexibility in the use of funds, particularly those provided under the capital program, if this potential is to be realised.*

(Section 1.8. p 2.
Baldwin 1991)

In practical terms there were a number of outcomes for Australian universities which I shall look at in terms of quality and of the introduction of new technologies into teaching. These are the two themes of this thesis, while the other theme of Baldwin's statement, that of participation in higher education, impacts on both of the other issues as the changing profile of university students strongly influences the methodologies appropriate for teaching in the universities, it will not be directly addressed in this thesis.

Quality Assurance and Performance Funding

The most direct effect on Australian universities of the statement of Peter Baldwin was the funds made available as an incentive to “increase the effectiveness with which they use their total operating and other resources and *in particular, to enhance the quality of their teaching*” (Baldwin 1991, my emphasis). The funds made available through the incentive scheme that was administered by the Committee for Quality Assurance in Higher Education was an allocation from 1994 of about \$70 to \$77 million (equivalent to two per cent of operating grants) over and above normal institutional funding on the basis of performance. This funding, generally known as ‘Quality money’, was allocated to universities not for indications of quality outcomes in the university sector, but rather for the quality of quality assurance procedures in place. In subsequent years the focus of the Quality funding assessment criteria have been teaching and learning in 1994, and research and community service in 1995 (see Chapter 4).

A More Flexible System

In this part of the policy statement (Baldwin 1991) new technologies and their potential to impact on university teaching is emphasised. The first point made in the summary of this section of the statement refers to the “Innovations in technology that have expanded opportunities for developing alternative ways of delivering higher education programs to both on-campus and off-campus students” (point 1.25, Baldwin 1991). The statement goes on to outline some of the ways this could be done:

The Government aims to promote developments in this area by funding a comprehensive review of modes of delivery, including distance education with a view to promoting approaches which take full advantage of developments in information technology.

Initiatives will include:

- *support for the development of alternative delivery approaches at the institutional level through the Reserve Fund;*
- *a comprehensive review of modes of delivery in higher education, involving examination of distance education by the HEC,*

evaluation of the use and potential of video-conferencing, and monitoring of the Government's open learning project; and

- *funding a National Centre for Teaching Excellence (as outlined in paragraph 1.12), part of the function of which will be to disseminate information on best practice in this area.*

(Section 1.28, p 7.

Baldwin 1991)

The 'National Centre for Teaching Excellence' had as one of its goals the promotion of 'approaches that take full advantage of developments in information technology'. This 'National Centre for Teaching Excellence' came into existence in August 1992 as the Committee for the Advancement of University Teaching (Baldwin 1992). This media statement includes the following:

The new Committee had its origins in Mr Baldwin's policy statement, Higher Education: Quality and Diversity in the 1990s (October 1991), which proposed the establishment of an independent National Centre for Teaching Excellence.

"After consultation with the higher education sector on that proposal I decided there was a more effective way of promoting good practice and facilitating innovation in university teaching". Mr Baldwin said.

(Baldwin 1992)

Thus the Committee for the Advancement of University Teaching was established as part of the reform of Australia's education system proposed in Baldwin's White Paper of October 1991. CAUT had a budget of approximately \$3 to \$5 million a year from 1993 to 1996 (see Chapter 5). In terms of the overall funding for universities this is not great, but the funds it provided are specifically for teaching initiatives within universities and as previously there had been no national fund to enhance teaching, these

funds were welcomed by academics interested in improving their teaching. CAUT has dedicated 80% of its annual budget to National Teaching Development Grants which are small grants (generally less than \$50,000) for projects which will improve teaching². As will be discussed in Chapter 5 a large proportion of these grants have been for projects involving information technologies. In more recent years CAUT has become increasingly explicit in saying that its role is not in promoting the use of technology in university teaching but rather *innovations* in teaching and that ‘CAUT does not espouse any one educational theory or particular method’ (CAUT 1995a). This however does not seem to sit well either with the policy statement of October 1991 which proposed the reforms to Australia’s higher education system that CAUT was to facilitate, nor with the guidelines for the National Teaching Development Grants in the first years they were offered: “In assessing proposals for funding CAUT will pay take (*sic*) account of the application of new technologies to teaching and learning, although this is not a necessary requirement’ (CAUT 1993a). These issues will be explored further in Chapter 5.

² The value of individual grants and the total CAUT National Teaching Development Grant scheme may perhaps be compared with those from the Howard Hughes Medical Foundation in the USA and the Teaching and Learning Technology Programme (TLTP) in the UK.

Through the Howard Hughes Foundation US\$290 million has been made available for *undergraduate science* education since 1988 (www.hhmi.org/grants/txtstart.htm) and over \$US450 million to enhance science education including pre-college and graduate science education since 1988 (www.hhmi.org/communic/annrep/president/start.htm).

The TLTP is funded by the British government through a number of university funding bodies. The stated aim of the TLTP is “to make teaching and learning more productive and efficient by harnessing modern technology” (University Funding Council 1992). Funds allocated to the Programme were UK£7.5 million a year over three years (Phase 1; 43 projects funded) and Phase 2 funding was UK£3.75 million for 1993-4 (33 projects funded).

Impact on Australian universities of the October 1991 statement

The impact on Australian universities of the Dawkins White Paper of 1988 which led to the amalgamation of many of the larger universities with smaller institutions, and the creation of new universities was still being absorbed when Baldwin's policy statement of 1991 was announced. The impact of Dawkins' 1988 statement was primarily a structural one with a cultural impact on the institutions involved, while Baldwin's statement of 1991 has set the direction for Australian universities for the 1990s. The funding made available as outcomes of the 1991 statement, in particular the 'Quality Money' administered by the CQAHE and the funds that were allocated by CAUT as National Teaching Development Grants, which are of interest here, have strongly influenced the activities of Australian universities in the early to mid-1990s. Both of these funding initiatives are incentive funds, that is, there is no compulsion for universities to either implement any quality methodologies or to undertake programs to enhance their teaching. All participation in the assessment by the CQAHE through submitting 'quality portfolios' and being visited by representatives of the committee is entirely voluntary, but with a share of approximately \$70 to \$77 million at stake all universities have participated in all rounds of quality assessment.

Similarly, all universities have applied for CAUT National Teaching Development Grants. In participating in this grant scheme the applying university has to commit a substantial amount of resources in the grant application process. Before a grant application is submitted to CAUT it had to go through a ranking procedure within the university. This ranking procedure involved senior members of the university, and a commitment that the project would be supported by the university if it was successful in gaining a National Teaching Development Grant. The involvement of senior members of universities in the ranking of grant applications was required by CAUT as it was believed that this would advance the cause of promoting the status of teaching within the universities. Since the establishment of CAUT there has been greater interest in teaching at Australian universities, with many universities now having 'Excellence in

Teaching' awards to reward and recognise good teachers. Some universities also have internal seeding grants to facilitate projects which then apply for a CAUT National Teaching Development Grant, while other universities give rewards to projects which are ranked by the university but fail to win a National Teaching Development Grant. All of these measures have raised the awareness of academics at Australian universities to the issues of teaching and, on an institutional level, rewards and recognition of good teaching have been introduced.

Conclusions

The Dawkins White Paper of 1988 led to substantial restructuring of the higher education sector in Australia, the effects of which are still being absorbed in many institutions. These changes have led to the current Unified National System of universities which receive most of their funding from the federal government. Peter Baldwin's policy statement of 1991 did not propose any further structural changes to universities but rather set the agenda for the coming years through setting a number of goals and then offering 'incentive funding' while still emphasising the autonomy of the universities. Although the scheme was voluntary all applied and the agenda set by the government has been followed.

The government initiatives for higher education of the early to mid-1990s this thesis investigates are (i) the introduction of 'Quality' practices in universities which were encouraged by the availability of substantial funds administered by the CQAHE generally known as 'Quality Money' (see Chapter 4), and (ii) the support for innovative teaching practices, most often interpreted as the introduction of new technologies in to teaching, through CAUT's National Teaching Development Grants (see Chapter 5).

CHAPTER 4 QUALITY FUNDING AND AUSTRALIAN UNIVERSITIES

The establishment of the Committee for Quality Assurance in Higher Education

One of the major outcomes of the White Paper of 1991 (Baldwin 1991) was the formation in November 1992 of the Committee for Quality Assurance in Higher Education (CQAHE). Preceding the White Paper of 1991 the Higher Education Council (HEC) had prepared a report on quality in higher education at the request of Peter Baldwin (June 1991). In October 1992 the report *Achieving Quality* (Higher Education Council 1992) was delivered to the Honourable Kim Beazley who was Minister for Employment, Education and Training at that time. In preparing this advice to the Minister the HEC had consulted with those that it considered stakeholders in the university process, especially academic staff, students, administrators, employers, and professional organisations. Other stakeholders acknowledged in the advice are governments, the community in general, and the international research and scholarly community.

The major recommendation from this report was the convening of a committee which would come into existence later that year as the Committee for Quality Assurance in Higher Education (CQAHE). The brief of this proposed committee included inviting universities to participate in a regular review and audit of their mechanisms for monitoring and improving the quality of their outcomes; examining portfolios prepared by the universities showing what they had done to put procedures in place to assure and improve quality; evaluating how universities had assessed the effects of their policies and processes; and to conduct interviews and visits as appropriate. The proposed committee would then make recommendations direct to the Minister on the allocation of specially designated funds to the universities “to recognise achievements demonstrated by the effectiveness of policies and procedures through an evaluation of their assessment of the quality of their outcomes” (Higher Education Council 1992). The committee would also be involved in advising the Minister on the part of the National

Priority (Reserve) Fund allocated for the development of quality assurance mechanisms and processes and related innovations, and on the funding allocations recommended as a result of the work of the Committee for the Advancement of University Teaching. This linking of the CQAHE and CAUT through the CQAHE advising on the recommendations of the CAUT is one that continued for the period of existence of the CAUT. Other activities of the proposed CQAHE included monitoring the benefits from funding previously allocated; disseminating information on best national and international practices; advising universities seeking assistance with quality assurance programs; and assessing and advising universities on a range of issues relating to quality assurance mechanisms.

Funding available through the CQAHE was recommended to be available from 1994, with \$75 million to be available in that year. The funds made available to a university in this way were recommended to not exceed three per cent of the university's operating grant and the funds allocated in this way (that is, as a reward for quality mechanisms) would not normally be earmarked in any way.

CQAHE: Guidelines from the Minister

The Committee for Quality Assurance in Higher Education was established in November 1992 as a non-statutory Ministerial advisory committee to "assist the government in the implementation of its strategy for ensuring the quality, excellence and international standing of Australia's higher education system" (CQAHE 1994). The objective of the committee was stated in the guidelines for the committee as:

The Committee's objective is to contribute, through its quality audit, advisory and other activities, to the effectiveness of the Quality Assurance Program and thereby to the maintenance and enhancement of the quality of Australian higher education through recognising and rewarding effective quality assurance, management, and excellence of outcomes in universities.

Institutions which are eligible to participate in the Quality Assurance Program are institutions which are members of the unified national system. Participation in the Program is voluntary.

(Appendix 2: Guidelines for the CQAHE. p 22

CQAHE 1994)

The quality audits made by the CQAHE were to be made in the areas of teaching, research, and community service. The recommendations for funding made available through this program were to be made by the Committee directly to the Minister. The report from the CQAHE to the Minister was to include a summary of the institution's statement of purpose or mission, and its objectives against this statement; a description of quality assurance practices and procedures and outcomes of these; a consideration of the adequacy and effectiveness of the policies and procedures in place, and the excellence of the institution's outcomes; and recommendations on the levels of incentive funding to each institution that the Committee considered to be appropriate (CQAHE 1994). These guidelines to the CQAHE from the Minister state that the Government had 'decided that around half of the institutions might be expected to gain a share of funds from the Quality Assurance Program', and that the maximum grant the Committee could recommend for any one institution was five per cent of the institution's operating grant. It was expected by the Government that a recipient institution would have a strategy for spending these funds in a way that would address the maintenance and enhancement of quality, particularly in the institution's areas of strength. Thus institutions which were to receive funding through the Quality Assurance Program were required to declare a strategy in which the funds would be spent to maintain and enhance quality at an institutional level (CQAHE 1994).

The relationship between the CAUT and the CQAHE was defined in the guidelines: CAUT was to consult with the CQAHE before it submitted its recommendations about the National Teaching Development Grants to the Minister.

The CQAHE was to ensure that CAUT's recommendations were consistent with the wider range of the Government's quality-related initiatives (CQAHE 1994).

Methodology of the Quality Reviews

The CQAHE first met in June 1993, and in July of that year issued guidelines to eligible institutions inviting them to participate in the program. Participation in the Quality Assurance Program was voluntary, and all eligible institutions chose to participate. Non-participation by an institution meant no chance of gaining a share of the available funds. The guidelines issued to institutions set out the objectives of the assessment process and gave a guide to preparation of a submission, termed a portfolio, from the institution, and indicated the areas that were to be reviewed by the Committee in 1993 and in subsequent years.

The contents of the portfolio submitted by an institution were at the discretion of the institution, and the portfolio and its supporting documents were to represent the institution's claim for additional funds. It was the responsibility of the institution to demonstrate quality rather than that of the Committee to prove or disprove it. The portfolio was first required not to exceed 15 pages, although this was increased to 20 pages after the first workshop held by the CQAHE. The portfolio submitted by an institution was expected to contain a report (20 pages) which reviewed the quality assurance processes and excellence of outcomes, and an outline of the institution's mission statement, objectives, governance, organisational, and management structures. An appendix incorporating data used by the institution to demonstrate the effectiveness of its quality assurance processes, the quality of its outcomes, and lists of supplementary documentation that could be made available to the Committee on request was also part of the portfolio submitted (CQAHE 1994, Appendix 4 - 'Guidelines for the Preparation of Institutional Portfolios').

The institutions were told that the following questions would be considered when assessing portfolios:

- *What quality assurance policies and practices does the institution have in place or is developing?*
- *How effective are these?*
- *How does the institution judge the quality of its outcomes?*
- *In what areas and in what ways are the outcomes excellent?*
- *What are the institutions' priorities for improvement? Note this question may be taken up in following years to ascertain what action an institution has since taken.*

(Section 7.6, Appendix 4 'Information for Universities', p 35.

CQAHE 1994)

The assessment of an institution's 'Quality Portfolio' was followed by a one day visit to the university by the 'quality audit team'. This audit team was made up of a member of the CQAHE (who chaired the team) and co-opted persons from higher education institutions and other appropriate agencies selected for their ability to assist the Committee in its audit task (CQAHE 1994). The co-opted members were there to provide greater breadth of experience to the teams and make the assessment process as transparent as possible. For the first round of assessments the audit teams were trained by Mr Peter Williams, Director of the Quality Audit of the UK Higher Education Quality Council. All team members participated in the training and a handbook was developed for members of the review team.

In auditing an institution the five questions stated above constituted a framework for the quality review process. The audit teams visited institutions for a single day to meet with senior management, staff, students, and community and industry representatives, and to enable the audit team to test the materials presented in the portfolio submitted by the institution.

Emphasis of Quality Rounds 1993, 1994, 1995

In the first round of quality reviews (1993) the CQAHE took an overview of the three areas of interest - teaching and learning, research, and community service. This was done so that baseline data could be collected so that changes in the system could be identified in subsequent reviews. In the 1994 review the emphasis was on teaching and learning, and in 1995 on research and community service. It was thus planned that over a multi-year cycle equal emphasis would be placed on teaching and learning, on research, and on community service.

In the 1994 round of quality reviews the emphasis was on teaching and learning, the stated scope of the audit being:

- *overall planning and management of the undergraduate and postgraduate teaching and learning program;*
- *curriculum design;*
- *delivery and assessment;*
- *evaluation, monitoring and review;*
- *learning outcomes;*
- *use of effective innovative teaching and learning methods;*
- *student support services and other teaching support services such as library and computer services;*
- *staff recruitment, promotion and development; and*
- *postgraduate supervision.*

(p 2.

CQAHE 1995a)

In 1994 the Committee sought answers to the following questions through the institution's portfolio:

- *What quality assurance policies and practices does the institution have in place or is developing for assuring the quality of its teaching and learning performance?*
- *How effective and how fully deployed are these?*
- *What processes does the institution have to evaluate and monitor the quality of its outcomes?*
- *Which quality related indicators does the institution use and why?*
- *What are the institution's priorities for improvement?*
- *What quality initiatives has the institution undertaken since the 1993 review and what evidence of improved performance is there?*

(Section 9.2. p 30.

CQAHE 1995a)

CQAHE and CAUT: Quality issues and innovation in teaching

One of the criteria for evaluating quality in the 1994 Quality audit was the 'use of effective innovative teaching and learning methods'. The high level of interest and activity in this area was in part ascribed to the initiation of the Committee for the Advancement of University Teaching (CAUT) and their 'annual national grants program in the area of innovation in teaching and learning' (the National Teaching Development Grants, see Chapter 5). In illustrating success in the focus of this round of quality funding (teaching and learning) many universities gave as evidence their success in gaining the competitive CAUT National Teaching Development Grants. The CQAHE report for the 1994 quality audit states that: "Innovation was often interpreted by universities to mean the application of educational technology" (CQAHE 1995). This link between the CAUT National Teaching Development Grants and information technology in teaching will be explored further in Chapter 5.

CAUT was required to consult with the CQAHE before making recommendations about National Teaching Development Grants to the Minister to

check they matched with quality guidelines (CQAHE 1994, CQAHE 1995a, CQAHE 1995b). The relationship between CAUT and CQAHE was defined thus:

The Committee [CQAHE] will also be consulted by the Committee for the Advancement of University Teaching (CAUT) on its recommendations for the award of Teaching Development Grants, before these are transmitted to the Minister. CAUT's relationship with the Committee [CQAHE] is, therefore, similar to the relationship between the Australian Research Council and its discipline panels with the exception that CAUT makes its recommendations direct to the Minister after consultation with the Committee [CQAHE].

(Section 3.2, p 32.

CQAHE 1994)

Spending of 'Quality Money' by universities

The funding allocated to universities by the CQAHE were expected to be spent in a way that would address the maintenance and enhancement of quality particularly in the institution's areas of strength (CQAHE 1994). The allocations by the CQAHE in 1994 and 1995 were lower than the budgeted amounts (\$78.6 million per year budgeted for 1994 and 1995) with the actual allocations being \$76.7 million and \$71.3 million respectively (NBEET 1995).

Funds from the 1993 quality audit were spent on enhancing teaching and learning by all institutions. The majority of institutions invested in new teaching technology

...such as teleconferencing and telelecturing facilities, networking of major lecture theatres so that information stored on a computer can be projected during lectures, enhanced network capabilities to provide improved access to university networks for all staff and students across campuses, and the development and production of quality materials for computer-managed electronic program delivery and computer-based learning.

Expenditure of funds from the other two rounds of quality audits were not publicly reported on but universities were expected to spend any allocated funds on the areas of the university that the round of quality review had focussed on. Thus it must be presumed that the bulk of the funds allocated from the 1994 round of quality review were spent on projects focusing on teaching and learning.

Conclusions

The initiatives of the Australian federal government in the early 1990s that stemmed from the White Paper of 1991, *Quality and Diversity in the 1990s* (Baldwin 1991) have had a major impact on Australian universities. The availability of these competitively available funds through the preparation of portfolios demonstrating quality practices has raised the awareness of quality issues in Australian universities. The funds allocated by the CQAHE in the years 1993-95 (\$70 to \$77 million per year) were equivalent to approximately two per cent of university operating funds. In a climate of reduced funding the 'Quality money' was a welcome supplement to traditional university funding. The funds allocated in this way were spent in a manner to maintain and enhance quality in Australian universities.

CHAPTER 5 SUPPORT FOR INFORMATION TECHNOLOGY IN TEACHING IN AUSTRALIAN UNIVERSITIES IN THE EARLY TO MID 1990s

The Committee for the Advancement of University Teaching

Australian universities receive most of their funding from the Department of Employment Education and Training (DEET)³. In June 1992 the then Minister for Higher Education and Employment Services, announced the establishment of the Committee for the Advancement of University Teaching (CAUT) with the primary aim to “advance the quality and status of teaching in Australian Universities” (CAUT 1993a). This new committee, as discussed in Chapter 3, had its origins in Baldwin’s policy statement, *Higher Education: Quality and Diversity in the 1990s* (Baldwin 1991), which proposed the establishment of an independent National Centre for Teaching Excellence with the role of disseminating information on best practices which take advantage on developments of information technology.

The Government aims to promote developments in this area by funding a comprehensive review of modes of delivery, including distance education with a view to promoting approaches which take full advantage of developments in information technology. Initiatives will include:

- ...
- ... and
- *funding a National Centre for Teaching Excellence (as outlined in paragraph 1.12), part of the function of which will be to disseminate information on best practice in this area.*

(Section 1.28, p 7.

Baldwin 1991)

A link with quality in Australian universities, and information technology in teaching were thus established from the very beginnings of the CAUT.

³ Recently renamed the Department of Employment, Education Training and Youth Affairs (DEETYA).

CAUT has established a number of initiatives to foster the desired advances in undergraduate education. The major initiative was the establishment of National Teaching Development Grants (NTDG) with other initiatives being National Teaching Fellowships, National Teaching Workshops, and the UniServe Australia clearinghouses.

National Teaching Development Grants

Eighty per cent of the budget of CAUT is directed towards National Teaching Development Grants. These grants are competitive grants which have been awarded annually since 1993 to teaching academics at Australian universities (in the Unified National System) for “innovative projects which have the potential for practical application throughout the higher education sector” (CAUT 1993a). CAUT aimed to advance the quality and status of teaching in Australian universities “By supporting the development of new approaches and practical improvements in teaching, learning and assessment”. Up to and including the 1995 round of grant applications (for projects in 1996) CAUT had received 1,968 endorsed applications and made 447 grants (CAUT 1994). Since the first round of grants in 1993 \$16.7 million have been awarded to NTDG recipients (Table 2).

Year	Number of grants awarded	Amount awarded in National Teaching Development Grants
1993	88	\$3.1 million
1994	136	\$5.1 million
1995	117	\$4.3 million
1996	106	\$4.2 million

Table 2 Committee for the Advancement of University Teaching's National Teaching Development Grants awarded 1993-1996.

A large proportion of the grants awarded were for information technology based projects (Table 3). The high proportion of successful grants being technology-based and the guide to applicants would have further influenced future applicants in the large proportion of grant applications being for IT based projects.

Year	Number of Grants awarded	Number of IT-based projects	Proportion of IT based projects
1993	88	56	64%
1994	136	94	70%
1995	117	84	72%
1996	106	75	71%

Table 3 Proportion of National Teaching Development Grants awarded to IT based projects.

Changes in 'Guidelines to Applicants' for National Teaching Development Grants from 1993 to 1997

Over the period that applications for National Teaching Development Grants have been invited (1993 - 1996, for grants awarded for 1993 - 1997⁴) there have been interesting changes in the section entitled "The Project" (Section 4.3) of the 'Guidelines for Applicants' regarding the use of information technology in the project (Table 4). In the earlier years (1993 - 1995) it would not be have been unreasonable for an applicant

⁴ Whether grants will be awarded for projects in 1997 is currently unknown.

to interpret this as implying the use of new technologies was being targeted by these grants for innovative teaching. Indeed, this seems to be the impression that most Australian universities gained as is reflected in the comments from the CQAHE in reference to the 'Quality Portfolios'. The CQAHE stated that: "Innovation was often interpreted to mean the application of educational technology" (CQAHE 1995a).

Year	Comments mentioning new technologies in Section 4.3 ('The Project') of 'Guidelines for Applicants' for National Teaching Development Grants
1993	"In assessing proposals for funding CAUT will pay take (sic) account of the application of new technologies to teaching and learning, although this is not a necessary requirement."
1993/1994	"In assessing proposals for funding CAUT will take account of the application of new technologies to teaching and learning, both on and off campus, and innovative procedures for student assessment. Applications involving new technologies (such as computer assisted learning) must be able to demonstrate how the use of the new technologies will enhance the teaching/learning process"
1995	Same as 1993/1994.
1996	No mention of new technologies made.
1997	"Applicants should note that the term 'innovations' should not necessarily be interpreted as meaning technological innovations."

Table 4 Changes in the Guidelines for Applicants for National Teaching Development Grants from 1993 to 1997.

Similarly, in the 'Introduction' section of the annual publication by CAUT 'Improving University Teaching: National Teaching Development Grant Projects' (CAUT 1993a, 1993b, 1994, 1995b) there have been increasingly defensive statements regarding projects involving new technologies (Table 5).

Year	Statements about information technology/computers
1993	“As will be seen in the following pages, a large number of projects involve the application of computers to the teaching process and we will be looking to see how ideas can be exchanged in this booming area.”
1994	“As was also the case last year, a large number of projects involve the application of computers and new communication technologies to the teaching process.”
1995	“As will be seen in the following pages a large proportion of projects involve the application of information technology to teaching and learning. This result has led to some comment and it needs to be stressed that this represents the range of applications received. We have no priorities within the NTDG program for any field or any pedagogical approach.”
1996	IT/computers not mentioned.

Table 5 Statements about information technology/computers in the introduction to the annual CAUT publication ‘Improving University Teaching: National Teaching Development Grant Projects’.

In CAUT’s ‘Annual Report 1994’ (CAUT 1995a) the move away from the emphasis on technology is again stated:

Despite the fact that CAUT has no priorities for its innovations program with respect to field or educational approach, a large majority of the proposals it receives focus on IT, especially computer related applications. CAUT welcomes this interest but, after each round, has felt it necessary to remind prospective applicants that teaching innovations are not necessarily limited to IT and, for example, may involve applying group dynamics to large or small group teaching, peer tutoring, techniques for relating assessment to learning, and other means of improving motivation.

(Chairman’s Statement, p v.

CAUT 1995a)

The reasons for this move away from new technologies as an emphasis of CAUT, indeed a denial that it was ever a priority, are unclear and have not been discussed in any of CAUT’s publications. However, the impression that CAUT National Teaching Development Grants were primarily for technology-based projects

seems to have remained with the academics applying for the grants. Perhaps after the first two rounds of grants many academics who were not interested in introducing new technologies into their teaching no longer considered applying for the grants as they were by then perceived to be targeting technology based projects.

Conclusions

The Committee for the Advancement of University Teaching, a committee of the federal minister for Higher Education and Employment Services, was established in June 1992. Since then it has been successful in stimulating activity and interest in teaching at Australian universities. This has been done primarily through National Teaching Development Grants which were allocated 80% of CAUT's budget. The information in the 'Guide for Applicants' for the National Teaching Development Grants in the early years the grants were offered could have been, and perhaps were, interpreted as implying a favouring of technology-based projects. During the period these grants have been awarded (1993-1996) about two thirds of these grants were allocated to technology-based projects, mainly computer-based projects. The allocation of a large proportion of grants to technology-based projects is likely to have reinforced the impression that the grants were largely for technology-based projects. Thus through the funding allocated by CAUT in 1993 to 1996 the development of technology based learning was supported by the Department of Employment Education and Training and the Australian government.

CHAPTER 6 DEVELOPING QUALITY TECHNOLOGY BASED LEARNING MATERIALS

Introduction

As with any products, if technology based learning materials are to be of a high standard there are a number of processes in their development that will enhance the likelihood of a quality outcome. Although not all of the processes will necessarily occur in every case where there is a quality outcome, including certain processes is likely to increase its probability. Some of these processes include the selection of members of the development team so that all required skill sets are represented, considering pedagogical approaches, and evaluating materials during the development process to ensure its fitness for purpose.

Development Team

The production of any quality piece of technology based learning material is unlikely to be developed by a single individual due to the wide range of skills required (Phillips 1993, Blum 1995). Whereas the preparation and the delivery of a lecture or tutorial may be undertaken by a single person, a wider range of skills is needed on the development team for TBL materials. The specific technical skills required will vary with the materials being produced with specific skills, such as those of animator or video camera operator needed only if animations or video are to be in the final product, while some skills such as computer programmer, graphic artist, content expert, instructional designer, and project manager are likely to be needed on all development teams.

Brian Blum (Blum 1995, p 56) in his book *Interactive Media. Essentials for Success*, subtitled 'The ultimate guide to designing and developing successful interactive media' suggests that the roles required in a development team for an interactive media project will include: producer, project manager/team leader, art director, artists and animators, information designers (known as instructional designers on educational projects), programmers, video crew, sound designer, media acquisition team, content owner, and upper management (or 'the client'). This range of skills and roles will not be

found in an individual, but some roles may be doubled up within an individual, and some roles may play a part in the team during only some phases of the development process.

The range of skills needed to produce effective educational interactive multimedia computer based learning materials has also been suggested to include: content expertise, graphic design skills, programming, project design, and management skills (Phillips 1993). It was proposed that the minimal requirements for in-house development of computer programs for the new Graduate Medical Program at the University of Sydney would be as permanent team members an educationalist, a graphic artist, a computer programmer, the transient attendance of the academic content expert, and a project manager (King 1995). Joel Greenberg of the Open University (UK) suggests that a project team on the development of educational multimedia materials should consist of academics, software designers, graphic designers, broadcast engineers, and staff with publishing and editorial skills (Greenberg 1995).

Although each of the authors above may have a slightly different title for team members, and Blum appears to be assembling a team for a bigger and more sophisticated project than the others, the basic roles needed in a development team appear to be a content expert, a computer programmer, a project manager, a graphic artist, and an instructional designer (referred to above variously as an educationalist, information designer, and project designer). The instructional designer will organise the material into a form that will “take an unstructured morass of information and try to make sense of it so it can be used in an interactive media program” (Blum 1995).

Educational Philosophy

A consideration of the educational philosophies to be used is important so that the approach of the TBL material will maximise learning. The two main styles of TBL materials are based on the two main approaches to teaching and learning, that is an instructivist approach and a constructivist approach. These two approaches in turn have their foundations in behavioural and cognitive learning theories respectively.

Behavioural Learning Theories

According to behavioural learning theories it is behaviour that can be directly observed that is important to learning rather than internal states which may or may not exist. Early workers important in this area of research were Ivan Pavlov (1849-1936) and Edward Thorndike (1874-1949). The studies of Pavlov and his colleagues in the late 1800s and early 1900s investigated what is now known as classical conditioning. In these experiments the salivation of a dog was measured and found to increase when meat (or meat powder) was presented to the dog. The meat was termed an 'unconditioned stimulus' and the salivation when meat was presented to the dog as an 'unconditioned response'. Before conditioning when a bell was rung (a 'neutral stimulus') no salivation occurred. However after training that consisted of a bell being rung when meat was presented, the formerly neutral stimulus of the bell being rung became a conditioned stimulus. That is, after training, ringing the bell (now a conditioned stimulus) produces salivation (a conditioned response) in the dog. In this work it was shown that learning could affect what had previously thought to be involuntary, reflexive responses such as salivating.

In the US in the early 1900s Pavlov's work inspired that of Edward Thorndike who went beyond Pavlov by showing that stimuli that occurred *after* a behaviour had an influence on future behaviours. Thorndike's experiments involved placing cats in boxes from which they had to escape to get food. It was observed that over time the cats learned how to get out of the boxes more and more quickly by repeating behaviours that led to escape and by not repeating those behaviours that were ineffective. From this Thorndike developed his *Law of Effect* which states that if an act is followed by a satisfying change in the environment, the likelihood that the act will be repeated in similar situations increases, and that if a behaviour is followed by an unsatisfying change in the environment, the chances that the behaviour will be repeated decrease. Thus the consequences of one's present behaviour were shown to play a crucial role in determining one's future behaviour.

Like Thorndike, B.F. Skinner (1904-1990) concentrated on the relation between behaviour and its consequences. Skinner concluded that if an individual's behaviour is immediately followed by pleasurable consequences, the individual will engage in that behaviour more frequently. This use of pleasant and unpleasant consequences to change behaviour is referred to as operant conditioning. Skinner's experiments involved, for example, placing a rat in a box isolated from outside stimuli where its behaviour could be observed. Inside the box was a bar that was easy for the rat to press, a food dispenser, and a water dispenser. In the earliest experiments the apparatus was set up to dispense a pellet of food when the rat pressed the bar. Thus when the rat accidentally pressed the bar a pellet of food was dispensed, reinforcing 'bar pressing' behaviour and weakening other behaviours such as wandering around the box. Other variations of this experiment included requiring the bar to be pressed a certain number of times before food was given.

From this work of Skinner and the results of many other studies using other species, including humans, the important principle of behavioural learning theory that *behaviour changes according to its immediate consequences* was established. Pleasurable consequences (reinforcers) 'strengthen' behaviour while unpleasant consequences (punishers) 'weaken' it (Slavin 1994).

This knowledge is used by parents and teachers on a daily basis with children where certain desirable behaviours are rewarded with treats, while undesirable behaviours are punished with withdrawal of treats or an unpleasant consequence. Similarly, in adult learners the reward of good grades and praise from friends, parents, or colleagues following successfully mastering material reinforces this desired behaviour (assuming that good grades are valued by the friends and family).

Applying this learning theory to TBL

Using this approach, instruction consists of stimuli, responses, feedback, reinforcement and other contingencies (Reeves 1995). Instructivists (those who use behavioural learning theory as the basis for instruction) stress the importance of goals

and objectives that exist apart from the learner, and little importance is put on the learner *per se*. Technology-based learning materials that are based on an instructivist approach include tutorials and drill and practice programs. One principle of behavioural learning theories that is frequently applied in TBL materials is that consequences that follow behaviours closely in time affect behaviours far more than delayed consequences. Thus TBL materials which give immediate feedback to the learner are likely to be more effective than if the same questions were given using traditional means, marked by the teacher and returned a week later (as is normal with much class work).

Other applications of behavioural learning theory to TBL materials includes ‘shaping’ where the frequency of reinforcement of desirable behaviours (mastering the content) is varied as the learner masters the steps along the way to mastering a topic. Thus learners are reinforced for behaviours that are within their current capabilities but which also stretch them toward new skills. Also used in many TBL materials (and books, *etc.*) is ‘cueing’, or the use of antecedent stimuli. These cues will inform the learner what the desirable outcomes will be, that is what behaviours will be reinforced, and/or what behaviours will be punished. Listing the goals and skills that will be mastered at the beginning of a TBL package fall into this category.

Cognitive Theories of Learning

Cognitive theories of learning, while not ignoring behaviour, place more emphasis on internal mental states. Learners are considered to have pre-existing knowledge, aptitude, motivations, and other characteristics. This view of learning involves the individual construction of knowledge through the learner reconstructing concepts and mental models (schemata) in the face of new information and experience that may conflict with earlier mental models. Constructivist approaches, which are based on cognitive learning theories, use ‘top-down’ processing in which learners begin with complex problems or tasks and discover the basic knowledge and skills needed to solve the problems or perform the tasks. Constructivist approaches also emphasise

generative learning, questioning or inquiry strategies, and other metacognitive skills. Problem based learning is an example of the application of cognitive learning theories.

One aspect of cognitive learning theories is that of schemata. In the 1950s Jean Piaget described the structure of knowledge as 'schemata' and emphasised children as active agents in their own learning. Schema theory states that information is stored in long-term memory in networks of connected facts and concepts that provide a structure for making sense of new information. These schemata were described as dynamic knowledge structures that represent past knowledge, guided one's interaction with the environment, and changed to reflect one's interaction with the environment (Goetz *et al.* 1992). New information that fits into a well-developed schema is retained far more readily than information that does not fit into a schema. One important insight of schema theory is that meaningful learning requires the active involvement of the learner, who has a host of prior experiences and knowledge to bring to understanding and incorporating new information. What is learnt from a new experience depends in large part on the schema applied to the experience.

One instructional model based on cognitive learning theories is 'Discovery Learning' which was proposed in the mid 1950s by Jerome Bruner. Bruner believed that an understanding of the nature of knowledge, and especially of how it is acquired and used is essential to providing students with quality education (Goetz *et al.* 1992). With 'Discovery Learning' learners are encouraged to learn on their own through active involvement with concepts and principles. Teachers encourage learners to have experiences and conduct experiments that permit them to discover principles for themselves. An advantage of this style of learning is that it arouses learners' curiosity, motivating them to continue to work until they find answers. Students must also learn problem solving and critical thinking skills because they must analyse and manipulate information.

In the early 1960s D.P. Ausubel stressed the need to emphasise active, meaningful learning. According to Ausubel, meaningful learning occurs when learners

assimilate new information to existing schemata by (i) identifying the most closely related existing knowledge structure, (ii) reconciling any contradiction or mismatches between the new information and prior knowledge (termed ‘accommodation’), and (iii) personalising the information by putting it into their own terms (Goetz *et al.* 1992).

Some of the metacognitive skills which are part of cognitive learning theories include thinking skills and study skills. This may involve giving students practice (and initially guidance) in questioning strategies, note taking, problem solving, and thinking skills. In addition, an emphasis on teaching with the ability to transfer learning to new situations is often an aim. That is, learners are given a wide enough range of experiences in applying their learning and problem solving, so that they are able to transfer the knowledge and skills learned to a wide range of new problems and situations.

From the cognitive learning theories comes the constructivist view of learning. Put simply, the constructivist view is that teachers cannot simply give students knowledge, rather learners must construct knowledge in their own minds. The teacher may facilitate this process by giving students opportunities to discover or apply ideas themselves, and by teaching students to be aware of, and consciously use, their own strategies for learning. Learners must constantly check new information against old rules and then revise the rules when they no longer work. Students thus have an active role in their own learning.

Applying this learning theory to TBL

Some of the ways cognitive learning theories are being applied include problem based learning and simulations of real life experiences in the safety of the classroom. Simulations may be of, for example, experiments which are too costly, dangerous, or unethical to perform, or situations where interpersonal or management skills can be tried out without real life consequences. The application of cognitive learning theories does not require the application of technology, but in particular for some simulations the use of technology is critical (*e.g.*, learning to fly an aeroplane).

One of the main proponents of applying a constructivist approach to technology based learning materials is Roger Schank of the Institute for Learning Sciences at Northwestern University (Illinois, USA). In his book *Engines for Education* (Schank and Cleary 1995) a number of principles of quality software are outlined:

Principle 1- Learn by doing: Learning should center on a task. The task should require those skills or knowledge we want to teach. The task should be challenging, but within the student's ability.

Principle 2 - Problems, Then Instruction: Students respond best to instruction when they see how what they are told relates to problems with which they are struggling. Instruction must clearly and directly address the real needs of the students.

Principle 3 - Tell Good Stories: Students respond to well-told stories. Educational software must contain interesting cases and tell them when and only when they relate to the students' problems.

Principle 4 - Power to the Students: Students should be in control of the educational process. Software may recommend what path to take, but students should always be able to stray from it to pursue their own interests.

Principle 5 - Provide a Safe Place to Fail: Reality is not always the best teacher. In some situations, it is unrealistic or dangerous to allow novices to practice in real situations. Computers can offer novices realistic simulations that provide a safe environment in which to make and learn from mistakes.

Principle 6 - Navigation to Answers: Software that instructs but does not let students ask questions removes control from students' hands. Students should be able to ask questions of the educational software they are using, and expect reasonable replies. Often, however, students do not know what questions to ask. In this case, it should be possible for students to navigate through an information base so as to easily discover what is there.

Principle 7 - The Software is the Test: Teachers want to know how much their students have learned. This is a reasonable goal, but, unfortunately, it usually leads to a multiple-choice test. Since the software we are talking about enables students to do certain things,

or to discover certain answers, the test is in whether the students demonstrates a new ability or makes a discovery. As long as the program can monitor what the student has been doing, no test is necessary. Instead, software can be thought of as having various levels of achievement and various gates that have to be opened to get to the next level. In order to reach a given level, the students must have been able to do the tasks leading to that level. No explicit tests need ever be given if the software has been correctly designed.

Principle 8 - Find the Fun: Learning should be fun. An instructional designer's single most important job is to make learning fun. No matter how well educational software is designed, if it is not fun it will not work well.

(Section entitled 'Principles of Quality Software'.

Schank and Cleary 1995, p175)

In the passage above Schank and Cleary allude to many of the points in the previous section – active learning, problem solving, use of simulations, being shown examples to facilitate transfer of learning, and developing questioning strategies.

Although also a proponent of a constructivist approach to learning, David Jonassen proposes that at each phase of knowledge acquisition a different approach to learning is required (Jonassen *et al.* 1993). Jonassen proposes that during the initial phase of knowledge acquisition a behaviouralist approach, with predetermined learning outcomes, constrained and sequential instructional interactions, and criterion-referenced evaluation, is suitable (Jonassen *et al.* 1993). At a more advanced stage of knowledge acquisition (that is, when the learner has a schema developed for the topic) a constructivist approach is more suitable.

That is, constructivist learning approaches and environments are not necessarily suitable for all learning contexts. Universities and secondary education institutions exist to foster advanced knowledge acquisition. Initial knowledge is usually acquired during

secondary and early university preparation. Most university curricula, however, especially in the student's major area of study, purport to promote advanced knowledge acquisition. Therefore, we believe that universities are ideal learning contexts for constructivist learning processes and environments.

(Jonassen *et al.* 1993, p233)

Thus a consideration of whether the content to be covered by the TBL material is directed at a novice or advanced audience should be considered, as well as the requirements of the content to be learnt. For example, if a specific procedure for using a specific piece of apparatus is to be learned or the audience has no existing mental models (schemata) of the material to be learned, then a behaviourist approach may be appropriate. However if the target audience is at a more advanced stage of knowledge acquisition, that is they already have a sophisticated schema of information in the area, or the skills and information learned are hoped to be transferred to other situations then a constructivist approach may be more suitable.

One difficulty in using a constructivist approach is that most learning institutions, whether for children or adults, have a perceived need to assess an individual's performance before they can 'graduate' or certify a participant. It is much easier to test the specific goals and requirements stated when using a behaviourist approach than the less concrete goals, such as 'problem solving skills' and 'thinking skills', of a constructivist approach to learning. This is a particular difficulty in higher education where examinations are an entrenched part of the university system.

Evaluation of Materials

In the development cycle of learning materials, including TBL materials, the evaluation of the materials as they are developed and after development is an important part of the production process. The evaluation of learning materials may be formative or summative. Formative evaluation of learning materials occurs during the development

of the materials and information gained from the evaluation contributes to the next cycle of development, thus effective formative evaluation of TBL materials will impact on their quality. Summative evaluation of learning materials is that evaluation undertaken when the development process has concluded and information about the effectiveness of the materials is to be gained. Therefore, although summative evaluation may give an indication of whether a quality outcome has been achieved, as its findings are not fed back into the development process it cannot influence the product's development, and thus will not impact on its quality.

There is a history of evaluation of learning materials that dates back to the 1930s, although most approaches used today have been developed in the last 30 years. Below is a brief outline of major evaluation theories. These approaches can be used for either formative or summative evaluation.

Goal Based Evaluation

Using this approach the stated goals of the program are the exclusive source of the standards and criteria of the evaluation process. Ralph Tyler (1950) defined educational goals in terms of student behaviours. The stated goals of a program are taken and evidence is then collected as to whether these goals have been achieved. The difference between the stated goals and the outcome is the measure of the success of the program. This approach assumes that there are pre-specified objectives and that there are some quantifiable outcome variables that the evaluator can measure to see if the objectives have been achieved. Tyler defined these goals in terms of behavioural objectives.

Decision-Making (CIPP)

All modern evaluation approaches suggest a connection between evaluation and decision-making. The decision-making approach proposes that the evaluation be structured by the actual decisions to be made. Daniel Stufflebeam (1973) defined four

types of evaluation: Context, Input, Process, Product, and this model is sometimes referred to as the CIPP model. Stufflebeam defined evaluation as:

Evaluation is the process of delineating, obtaining, and providing useful information for judging decision alternatives.

(Stufflebeam 1973. p129)

An evaluator using decisions as the basis for their activities does not require information about objectives but rather about what decisions are to be made, who is to make them, on what schedule, and using what criteria.

Goal free evaluation

The goal-free approach to evaluation was a direct reaction to the ubiquity of goal-based evaluation. Scriven (1973) maintained that not only should the evaluator not base their evaluation on the program's goals, but they should remain deliberately uninformed about what these goals are in order not to be biased by them. Scriven's aim was to reduce bias in evaluation.

This approach is not widely used in isolation, but more frequently in a combination with other forms of evaluation. It is particularly appropriate to some forms of evaluation such as consumer groups where if, for example, a toy, in addition to achieving its stated objective of entertaining children, also choked or harmed them in some way then this 'side effect' is at least as important as the stated goal. Environmental Impact Statements are also based on this approach, as all effects — planned and unplanned — are of critical importance to the assessment of a potential project.

Scriven wrote:

The 'side effects' whether good or bad often wholly determine the outcome of the evaluation. It is obviously irrelevant to the evaluator whether there are 'side' or 'main' effects. That language refers to the intentions of the producer, and the evaluator isn't evaluating intentions but achievements...

(Scriven 1973, p321)

The goal-free approach to evaluation is of great value when used in conjunction with more defined approaches. It allows the evaluator to gain a greater knowledge of the effects of the program being evaluated and to determine the unexpected 'side effects' that may be produced by the program. These findings can be of immense value in the evaluation of a program.

Connoisseurship Model

This model was proposed by Eisner (1979) and is similar to the 'critic' approach in art, literary, and theatre criticism. It is a judgmental model and utilises a human as the measurement instrument. For this approach to be successful the connoisseur must have a great deal of experience so as to be able to distinguish what is significant about the program. As an adjunct to this, others who read the evaluation of the connoisseur should have an increased awareness and appreciation of the aspects to be considered in the evaluation of a program.

Data collection, analysis, processing and interpretation take place within the mind of the judge and are hence not open to direct inspection. The judge/connoisseur has inside their head the 'critical guideposts' that they have internalised as a result of training and experience. Eisner defines connoisseurship as the 'art of perception that makes the appreciation of such complexity possible'. The connoisseur by virtue of their background, is able to 'appreciate' the characteristics and qualities of phenomena that they observe to a better degree than is a less sophisticated observer.

There are a number of problems associated with this approach which include knowing what confidence can be placed in the critic's evaluation. However, if a connoisseur's judgement is respected this can provide a very useful source of information for either formative or summative evaluations.

Naturalistic Approach

This model was proposed by Lincoln and Guba (1981) and they define evaluation as:

... a process for describing an evaluand and judging its merit and worth.

In this style of evaluation it is organised around participants' concerns and issues. Qualitative data such as interviews and journals are used in this methodology. This approach has moved away from the goals-based approach where the attainment of goals drove the evaluation. Four main criteria for this type of evaluation are: an improvement of the entity; a critique of the entity; adapting the entity to a particular context, and certification of the entity in the new context.

Which evaluation model to use?

A combination of evaluation models is often a more powerful evaluation tool than strictly adhering to a particular approach. For example, a combination of a quantitative methodology (e.g., a goals-based or systems analysis approach) and a qualitative methodology (e.g., a goal-free or naturalistic approach) can give the evaluator a powerful combination of results for either formative or summative evaluation. This has been suggested by Alexander and Hedberg (1994) where they propose a series of questions to be considered at various stages of development. From these questions a variety of methodologies of evaluation take place at the stages of development (Table 6, from Alexander and Hedberg 1994). Should these information gathering and evaluation methodologies been implemented in the development of a TBL program it is likely that the quality of the TBL program developed will be enhanced.

Activities	Information gathering	Purpose	Evaluation questions	Methods
Design	Analyse (needs)	To provide information for planning	1. What are the areas of curriculum in which students experience greatest difficulty? (see Laurillard, 1993 p 228) 2. Is TBL the most appropriate way of dealing with this difficulty?	1a. Interviews with experienced teachers 1b. Review of the literature on teaching in the subject 2. Review of learners, learning context, evaluation of other non-technology based learning strategies (e.g., reflective journals) and other existing packaged solutions
	Formative evaluation	To inform decisions made in the design of the technology-based learning program	3. What educational strategy should be used? 4. Is the user interface appropriate to task and conceptual models of the ideas?	3. Review of literature to determine what is known about the way students learn the particular topic 4. Walk-through rapid prototype or storyboards with potential users and media experts
Develop	Formative evaluation	To inform decisions made in the development of the technology-based learning program	5. Is the user interaction effective and efficient? 6. What and how are students learning? (using this program) 7. What is the merit of this program?	5. Observation, videotaping, user-tracking, interviews with/of users and expert reviewers 6. Stimulated recall, critical incidents, think aloud as target students use program 7. Peer review
Teach	Summative evaluation	To determine the worth of the of the technology-based learning program in the context of its use	8. What changes in understanding have students undergone as a result of using the TBL program in this context? 9. Is the program a 'valid' approach to addressing the stated learning need?	8. Pre- and post-tests/ questionnaires/ interviews 9. Expert/peer review
Institutionalise	Impact evaluation	To determine the transfer of the students' changes in understanding to the context of its use	10. Do students apply new understandings to the context of use? 11. What has been the impact of this TBL solution on other aspects of the curriculum, learning and the organisation?	10a. Problems requiring understanding to solve 10b. Longitudinal studies using interviews, reflective journals and relevant data 11a. Interviews with participants and key stakeholders 11b. Review of organisation documents
	Maintenance evaluation	To determine the contextual validity of the technology-based learning program	12. Is the TBL program 'valid' in the current context of use?	12. Expert review

Table 6 Integrated evaluation approach (from Alexander and Hedberg 1994).

Can technology based education achieve quality?

The concepts of 'Quality', and 'Total Quality Education' are not simple ones that can be addressed with a single 'magic bullet'. As was stated earlier, TQM has as its primary philosophy 'The first priority of an enterprise and everyone in it must be knowing and satisfying the customer' and a number of underlying principles (Seymour 1993).

Just as a business wishing to move to Total Quality Management cannot achieve this by buying a piece of software for the business, neither can a university (or department, or subject/unit) achieve a Total Quality Education experience for their students by using TBL, no matter how brilliant it may be. This is certainly not an argument against the use of TBL materials in higher education, but rather an acknowledgment that TBL itself is not a magical solution to raising the quality of education, though it may play a role in raising the quality of the education process.

For any course to achieve TQE there must be a commitment from the staff and a great involvement of the students in the course and a commitment to achieve the goals. This cannot, of course, be obtained through using a software package in a course, but rather must be worked at and may be achieved through the processes incorporated into the course.

Problem-Based Learning as an approach to achieving TQE

One way that has been proposed to move towards a TQM approach to education is through problem-based learning (Hadgraft and Holecek 1994) which has a constructivist approach to learning. Problem-based learning (PBL) has found acceptance in many courses as it has benefits seen as essential to graduates as it gives them skills in:

- adapting to, and participating in, change;
- problem solving in unfamiliar situation;
- reasoning critically and creatively;
- using a systems, or holistic approach;
- collaborating productively in teams;
- identifying one's own strengths and weaknesses; and
- committing oneself to lifelong learning as a means of addressing the problems.

(Hadgraft and Holecek 1994)

Problem-based learning is student-centred process where developing the above skills are of paramount importance. It must be ensured that a PBL approach is a shared vision of staff and students so that the staff are open to innovation and contributions by students. Students can be part of their own education and take pride in it, rather than feeling that they are merely receptacles into which information is force fed. The feeling of responsibility for, and pride in, their education goes a considerable way to attaining a TQM approach to education. As a part of a PBL approach there is ongoing communication between staff and students - this will, one assumes, ensure that the standard of a student's work is known to be of at least a pass standard by the time work is submitted. This is likely to be more efficient than waiting until the end of the process and failing a proportion of the class for substandard work. This 'Inspection' model was one rejected by the manufacturing industry in the 1930s as inefficient. The costs for students required to repeat units should be factored into the cost of traditional means of presenting materials when compared with costs for implementing, for example, a problem-based approach.

An important part of TQM is eliminating fear - and this too is of direct relevance to improving education. If a student is driven by fear of failing exams, that passing exams is the sole goal rather than understanding the material, then students are more likely to hide their mistakes or weaknesses rather than gaining a better understanding by asking questions and making suggestions. This latter way is more likely to lead to the student being a better graduate of the university. Similarly, if students learn how to work in a team they will be seen as a better graduate of the university and a better professional. In businesses of all sorts a team-based approach is the norm. Traditionally universities did not encourage collaborative work, but rather frowned upon it. Teamwork at university is more likely to equip the graduate with skills needed in their future career and life. It also allows students to tackle much larger questions and issues than could be done by individual projects – thus enabling students to participate

in research activities nearer the leading edge. This too could generate research papers and thus research funding.

Overall a problem-based approach to learning, using teams to tackle the problems will allow the students to take responsibility for their own education and to take pride in their learning and results. Individuals will generally work harder if they are part of a team as they do not wish to let the team down, thus the work is of higher quality. Any competition between teams may also enhance the quality of projects. These factors combine to make up a quality experience for the staff and students as well as a quality graduate for future employers and the community.

The combination of Problem Based Learning and technology in education is one that was used by the projects of four respondents to the questionnaire (Chapter 6). One of the projects is intranet-based where students research the topic beginning with Web pages built by the developer, and the other three projects present a number of 'problems' and include resources for the students to explore, construct meaning, and synthesise their analysis of the problem presented to them.

Two examples of Technology Supported Problem Based Learning

Problem based learning is one being applied to an increasing number of technology based learning packages. The combination of problem based learning and technology is one which has the possibility of combining the concepts of Total Quality Education and Technology Based Learning when the materials are delivered as a part of an overall Quality approach to the educational process.

Two examples of combining PBL with TBL are briefly outlined below. One is Australian (the Graduate Medical Program at the University of Sydney) and one is from the USA (*BioQUEST Library*). The *BioQUEST Library* has been developed by university academics and is available commercially, while the materials for the Graduate Medical Program at the University of Sydney are currently being developed for delivery beginning in 1997.

There are a number of other problem based learning packages available, the reasons these two are discussed here is that the developers of these two groupings of TBL materials have approached biological education and medical education respectively in a holistic way. The goals of both the BioQUEST consortium and of the Graduate Medical Program are to train the student to be a biologist/doctor through giving them a simulated experience of being a biologist/doctor, and embedding the technology-based materials into a greater philosophy and structure into which the computer based materials form a part, but by no means all, of the educational process. In both examples the role of interactions with other students and communicating with them is critical.

BioQUEST Library

The BioQUEST Curriculum Consortium is made up of biology educators from all over the USA who contribute to the materials on the annually released *BioQUEST Library* (available on CD-ROM) of learning materials in the biological sciences. The Consortium shares the approach stated by the American Association for the Advancement of Science that: “science should be taught as it is practiced at its best” (AAAS 1990) and that:

There is wide acceptance that one important goal of education is to give students experience in solving problems. If this is just accepted, then it is necessary to deal explicitly with problem solving and not just with solutions ... our students must come to accept science as a powerful device for achieving human goals while realising that it is both inappropriate and impossible for science to define those goals. Science is an expression of what it is to be human.

(Moore 1986, in BioQUEST 1994a)

Thus, the BioQUEST Curriculum was formed as “a means of initiating curriculum reform in undergraduate biology courses through creation and dissemination of innovative and flexible instructional learning tools and the establishment of a

communication network for like-minded faculty” (BioQUEST 1994a). The group has what it calls the ‘3 Ps of science education’, that is Problem Posing, Problem Solving, and Peer Persuasion. As a part of this (but by no means all) there is a number of software packages that allow the student, through a simulated experiment, to gather data as part of the problem solving phase of the process. (The simulated experiments supplement but do not replace practical work). The software in the *BioQUEST Library* have the following characteristics:

- (1) novelty of problems each time a program is run,*
- (2) realistic outcomes for each experiment performed,*
- (3) infinite opportunities to perform experiments,*
- (4) computational power,*
- (5) speed in obtaining results,*
- (6) large data size,*
- (7) facilitating successive hypothesising and logical and numerical testing,*
and
- (8) sequentially developed problem difficulty involving and increased quantity of natural phenomena.*

(Jungck and Calley 1985)

Through this combination of experimental simulations with this educational philosophy and, most critically, committed staff, technology is being used as an important part of a quality education. It is used to train biologists through giving them the opportunity to ‘experience’ science from the view of a practicing biologist rather than being presented with facts, figures, and the ‘cook book’ procedures required for completing a practical class in a set three hour time slot.

The way the materials of the *BioQUEST Library* is implemented is critical if the goals of the BioQUEST Curriculum Consortium are to be met. If the materials were used in a traditional style of teaching with the simulations being used simply as a substitute for laboratory classes then the likelihood of achieving the goals of the consortium would be compromised.

Graduate Medical Program, University of Sydney

A major project combining Problem Based Learning and technology is that is currently being developed at the University of Sydney for the Graduate Medical Program. In this program, which will begin in 1997, the traditional didactic approach of the training of medical doctors will be replaced with PBL in groups of about seven students, with a facilitator (a member of the teaching staff), and a networked computer. The 'problems' will be presented to the group via the computer using text, audio, images, and video as appropriate. The chosen delivery vehicle is using the Netscape Navigator software and ancillary 'plug-ins' that allow the delivery of associated materials such as video, sound, and animations. The group, with the facilitator to guide them, will discuss and research the problem using traditional library resources as well as resources available via the Internet and any other resources available, whether electronic (such as MedLine) or not. Problem-based learning (but not necessarily involving the use of technology) has been used in the medical program at the University of Newcastle for two decades.

The development of technology based teaching and learning materials for use with problem based learning, in particular the development of resources that can be delivered via an intranet or the Internet, means that any TBL materials developed in this way will have a useful lifespan that extends well beyond that of most TBL products. The advantage of PBL materials being developed with delivery of the 'problem' being via the computer is that a wide range of resources (video, sound, high quality images, *etc.*) can be integrated and the same resource can be used in more than one problem if appropriate. Although production of some of the resources (such as video⁵) may be time-consuming and thus expensive, the integration of resources is simple using the standard hypertext markup language and easily modifiable by a person with little or no

⁵ Costs of production of materials for the Graduate Medical Program at the University of Sydney have been minimised by using a series of still images with an audio track where appropriate. This conveys the same information but reduces costs compared to full scale video production.

programming skills. Most importantly, however, is that the resources needed to investigate the ‘problem’ are not part of the materials produced by the development team, only the problem, or ‘trigger’ is presented on the computer. Students must search out relevant information from a wide variety of sources to investigate the problem, just as they will have to do in their professional life. If the information to investigate the problem was embedded in the teaching materials not only would the workload of the development team be multiplied many-fold, but it would also need to be constantly updated as each new drug was released onto the market. In addition, in medicine, as in most academic fields, there is more than one ‘solution’ to any given problem and to attempt to cover all of these in a software package would be a mammoth task.⁶

The change to PBL in some tertiary courses also reflects the changing expectations of employers who expect graduates to be able to work as a team member, to be able to communicate well, and be capable of lifelong learning. The traditional style of university education has not specifically stated and targeted these goals, though of course a large proportion of graduates do have these qualities. In these days of mass education a more focused approach to attaining these goals may perhaps be required.

Conclusions

Developing technology based learning materials should be viewed as developing *learning materials* that are technology based, that is with an emphasis on the learning, and less emphasis on technology. With this in mind, although there may not yet be a vast literature on specifics such as how to structure a development team for TBL materials, there is a long history and vast resources that should be consulted on both learning theories and evaluation methodologies and protocols. It seems from observation of many developers of TBL materials that too often little heed is paid to the knowledge or long history of investigations into these areas.

⁶ There are also lectures in the first two years of the four year program and other CAL materials available to the students.

To develop good quality TBL materials the developers should determine a need for material to be delivered using TBL materials, evaluate learning theories that will relate to the learning outcomes and skills to be developed to ascertain which approach is most suitable, plan formative evaluation strategies for the development process, and gather together a development team with the appropriate range of skills to achieve the goals of the project. This will not guarantee a quality TBL material as the outcome, but it will increase its likelihood.

The quality of TBL materials, including materials developed on CAUT National Teaching Development Grants, is dependent on the processes of their development. In 1993 when the first round of National Teaching Development Grants were offered, there existed a long history of development of non-technology based instructional materials. Thus, although there may not have been many models for developing TBL materials available to applicants for NTDGs, the models for developing other teaching materials, for example for distance education, were available. There is a parallel between instructional materials developed for distance education and those technology-based materials to be used at the student's 'own pace and own place', as is claimed for many TBL materials. Thus the lessons learned from developing distance education materials should have been transferred to developing learning materials that are technology-based.

Thus if the CAUT was to increase the likelihood of quality outcomes of the technology-based projects funded by the National Teaching Development Grants then the grant recipients should have been knowledgeable about the processes involved in developing teaching materials. This includes gathering together a team in which all of the required skills were represented, choosing an educational approach that suits the content, and ensuring that effective formative evaluation was a part of the development process.

CHAPTER 7 WERE 'QUALITY' ISSUES ADDRESSED BY CAUT NATIONAL TEACHING DEVELOPMENT GRANT PROJECTS?

Introduction

In any investigation of 'quality' it is unlikely that there can be a single measure to determine whether quality processes and outcomes are being achieved. The scope of the current study is certainly not broad enough to determine if the CAUT National Teaching Development Grant scheme has led to an outcome of quality learning in Australian universities. A much larger study entitled *Evaluation of Information Technology Projects for University Learning: The CAUT Experience* has been commissioned by CAUT looking at some of these issues. This commissioned study, due to report in March 1997, is being undertaken by Associate Professor Shirley Alexander, of the University of Technology, Sydney.

What shall be looked at in the current study is a glimpse at how some grant recipients in the sciences have approached the projects funded by the grants, the development process, and the use of the products developed on the grants. Through this some indication may be gained about the possibility of enhancing quality in education through such products. It is acknowledged that Total Quality Education cannot be implemented simply by the introduction of any teaching package, technology-based or otherwise, no matter how good that teaching material is.

Through the CAUT National Teaching Development Grants the Department of Employment, Education and Training injected \$3 to \$5 million a year from 1993 to 1996 for innovations in university teaching. As has been discussed in Chapter 5 a large proportion of these funds were directed at projects that were for the development of technology-based teaching and learning resources.

If the design process in developing the TBL materials was flawed then it is perhaps unlikely that quality outcomes would be produced. Without a product that is of a high quality it is unlikely that the learning experience of students will be enhanced.

and even less likely that the material would be adopted by educators at other institutions. The aim of the National Teaching Development Grants for “innovative projects which have the potential for practical application throughout the higher education sector” (CAUT 1993a) would be unlikely to be achieved under such circumstances.

There is now a broad understanding of the design process for developing quality technology-based teaching and learning materials (see Chapter 6). This chapter will investigate some aspects of the design and development processes undertaken by the CAUT National Teaching Development Grant recipients who responded to the questionnaire. Specific aspects investigated include: the experience of the project team leaders in developing TBL educational materials; the choice of instructional paradigm: the inclusion of an instructional designer in the development team; and the extent of formative evaluation of the product by students. Also investigated are the extent to which the products are being used and the perceived effects on students and colleagues of both using and developing these materials. Through these investigations, the extent of the CAUT funded projects taking the understanding of the design process for developing quality technology-based teaching and learning materials into account and thus producing quality materials and adding to the quality learning approach will be explored.

Methodology

A series of questions (Appendix 1) were sent via email to recipients of CAUT National Teaching Development Grants for 1993, 1994, and 1995 for projects which were technology-based and in the sciences. The reasons those contacted were grant recipients in the sciences were (i) that there was a higher representation of TBL projects in the sciences (78%) than for all disciplines (68%), and (ii) the author had familiarity with a number of the science projects developed on CAUT National Teaching Development Grants through association with UniServe•Science.

The questions were sent to the team leaders of all CAUT National Teaching Development Grants from 1993, 1994 and 1995 in the sciences. Five team leaders could not be contacted as they had left the host institution where they had held the grant or had retired. Nineteen team leaders (or a person nominated by them) responded to the questions by email and three were interviewed on the telephone, giving a response rate of 43%. As for any questionnaire this less than 100% response rate was expected and to some extent the respondents were self-selecting. Responses may thus be skewed because of this self-selection and also because of the selection of science projects. Without the ability to compel National Teaching Development Grant recipients to respond, this is a limitation of any study of such a group. The response rate has possibly been depressed by the large number of reports and questions grant recipients have been asked to complete since receiving a CAUT National Teaching Development Grant.

Results

Background in developing technology-based learning materials

There was a wide disparity of background and experience of respondents in developing teaching materials, in particular in developing technology based teaching and learning materials. Almost half (9, n=22) had not been involved in the development of any technology-based teaching materials before the CAUT funded project (Table 7). Of those that had developed such materials (13, 59%), experience ranged from development of CAL materials over the previous 10 years to experience as a team member on a technology-based CAUT National Teaching Development Grant the previous year. One respondent had produced CAL materials with funding from the National Priority (Reserve) Fund through a university grant, and another had produced pilot CAL programs before receiving the National Teaching Development Grant.

While some recipients of grants had not developed technology-based learning materials, one had done research into student learning in his discipline and was thus well prepared in terms of the educational goals they hoped the materials developed would

attain. Another had written a book on the material that was covered by his National Teaching Development Grant project and felt that the material would be better presented with CAL than could be achieved in print. Six respondents had not developed any CAL materials before the CAUT grant and did not mention any background in developing any other teaching materials.

On the whole, few respondents had extensive experience with developing teaching materials with the use of computers before receiving the National Teaching Development Grant. This is not particularly surprising given that very few people in the Australian, or indeed any, university system had developed such materials prior to 1993. However, the lack of experience of the team leaders in developing TBL materials would reduce the chances of quality outcomes from the individual projects. Many team leaders were content experts with no experience or knowledge of the issues involved in developing TBL materials, this is not a helpful start if a quality product is the desired outcome.

Project Number	Had developed CAL materials before applying for NTDG	No CAL materials developed before applying for NTDG
1	•	
2	•	
3		•
4	•	
5	•	
6		•
7	•	
8		•
9		•
10		•
11	•	
12	•	
13		•
14		•
15	•	
16		•
17	•	
18	•	
19	•	
20	•	
21		•
22	•	

Table 7 Had computer aided learning materials been developed before applying for the CAUT National Teaching Development Grant.

Instructional paradigms used

For almost all projects a combination of instructional paradigms were used in the material developed, though one respondent disliked the term and claimed not to use any (Table 8). There are, therefore, data for 21 projects and up to five claimed instructional paradigms for each project. Most projects (13) had a tutorial approach, most usually in combination with at least one other approach, often a simulation or questions with feedback. Although not an instructional paradigm, three developers claimed it to be so and used the ability of computers to display animations of the content material. this included, for example, animations of molecular interactions and of biological systems. The TBL materials developed by four respondents used a problem based learning approach. This was described by one of the respondents as ‘cooperative problem solving’ and another as ‘reasoning’. Thus most projects (tutorials) had an instructivist

approach, although sometime with a constructivist component (a simulation). Only the four problem based learning projects used a constructivist approach.

For one project the aim was to replace a practical class that was not successful due to students not having sufficient technical background knowledge and skills and to reduce the costs of consumable items and technical resources for the practical class. The practical class is now replaced with the simulation of the laboratory exercise. This was seen to be acceptable as any 'hands on' skills gained in the laboratory class were not the primary aim of the laboratory class.

That such a large proportion of projects were tutorial style, that is used an instructivist approach, at this level of education should perhaps be questioned. As discussed in Chapter 6, Jonassen (1993) proposed that although an instructivist approach is suitable for learners at the initial phase of knowledge acquisition, at a more advanced stage of knowledge acquisition a constructivist approach is more suitable. At the tertiary level it is hoped that learners are gaining advanced knowledge, building on prior knowledge, and developing higher order thinking skills, thus a constructivist approach should be appropriate at university level.

Project number	Tutorial	PBL	Simulation	Q & A	Learning Resource	Animation*	Information Landscape	Game
1	•		•		•			•
2			•	•				
3					•			
4	•		•					
5	•			•		•		
6		•						
7	•				•		•	
8			•		•			
9	•			•				
10								
11	•		•		•			
12	•			•				
13	•		•	•				
14		•						
15	•		•					•
16			•				•	
17		•					•	
18	•			•				
19	•					•		
20	•		•		•	•	•	
21		•						
22	•			•				

Table 8 Instructional paradigms used in respondents' projects.

* Claimed as an instructional paradigm by three respondents.

Instructional Designers' involvement in the projects

Only about half of the respondents (10, n=21) used the services of an instructional designer (or similar) in the development of their TBL materials (Table 9). There was a wide range of responses to the question "Did you use the assistance of an instructional designer (or similar) in the development of your project?" ranging from: 'What is an instructional designer?' to: 'Most definitely!'. For six more of the projects the team leader also acted as instructional designer. In all but one case the team leader had no formal training in instructional design (or at least did not state that they had any training or expertise in the area).

That any of the teams lacked an instructional designer (or similar) is disturbing as it suggests that in addition to the lack of experience in developing TBL materials (as shown above) a number of the project leaders had not done adequate research into how learning materials should be prepared and the processes and skills required. Although when the NTDG scheme started in 1993 little was written specifically about

development teams for TBL materials, there was extensive experience and knowledge about teams required for developing traditional learning materials. Much of this can be transferred to development of TBL materials. That CAUT did not direct grant applicants to such information meant that for many projects where the team leader did not have experience in developing teaching materials then opportunities to produce better materials were perhaps wasted through skills missing in the development team.

Project Number	Instructional Designer used	Team leader acted as Instructional Designer	No Instructional Designer
1	•		
2			•
3			•
4	•		
5		•	
6			
7	•		
8	•		
9		•	
10		•	
11			•
12	•		
13		•	
14			•
15	•		
16	•		
17	•		
18			•
19		•	
20	•		
21		•	
22			•

Table 9 Was assistance of an instructional designer (or similar) used in the development of the project.

Formative Evaluation: Student Involvement

About half (11, n=21) of the respondents used students for gaining feedback on the materials during the development phase of the materials to a greater extent and about half (10) to a lesser extent (Table 10). With few exceptions the materials were trialed on students only toward the end of the development phase and the student feedback was used for modification of the materials at that stage. A smaller number of projects used student feedback extensively throughout the development process, for example on one project: 'Two students test drove the product at all stages of development' and on

another: ‘Students were involved in the formative evaluation of the package as it was developed’.

Three projects had students on their development teams (as programmers in two cases) and another: ‘ended up with students in the reference group and actually involved in the development work as well as being the recipients and contributing useful feedback that has led to ongoing refinements of the CAL resources’.

CAUT did well in suggesting to grant applicants that students be involved in gaining feedback about the materials being developed from students. However, it seems that as about half of the projects used students for evaluation during the final phases of development that the formative evaluation by students at this stage could have only limited impact on the materials produced. Again, that many projects only involved students late in the development phase reflects a lack of both experience and knowledge about developing learning materials. Directives from CAUT about the involvement of students in evaluation may have needed to be more specific about the value of early and regular formative evaluation in producing a quality product.

Project Number	Greater extent	Lesser extent
1	•	
2		•
3		•
4		•
5	•	
6		
7	•	
8	•	
9		•
10		•
11	•	
12		•
13		•
14	•	
15	•	
16		•
17	•	
18		•
19		•
20	•	
21	•	
22	•	

Table 10 Student involvement in evaluation of the learning materials.

Use of materials developed with a CAUT National Teaching Development Grant

Materials developed are being used by students in most cases (n=21), with one respondent reporting that there were no completed outcomes: 'due to an underestimation of the time and money required' (this project was funded in 1993), and one project has not yet been completed (funded in 1995, expected to be completed in late 1996). Materials developed by all other projects are being used by students (Table 11). Materials from six projects are not incorporated into scheduled classes, but are available to students as an optional supplement to classes. Almost a third of the material developed being used (or perhaps not used) in this way raises more questions than it answers – Do the developers think the material is good enough to replace classes? Are there facilities available to deliver the material in class? Is there structural resistance to replacing class time with scheduled computer-based activities? It is beyond the scope of this study to follow up on these issues but the apparent resistance of replacing class materials with TBL materials, even by the developers of the materials, is worthy of further investigation.

Of the other materials developed, eight are used in practical classes, one is used in a tutorial class, and four are used in lectures (one of these is also used in tutorials). Those used in lectures tend to be animations or videos demonstrating processes that are difficult to visualise and thus difficult to teach without the assistance of technology. One product was used to replace 15 hours of lectures, this is by far the most time materials developed are used in class time and is the only product that actually *replaces* contact time rather than being used in a class time or as an optional supplement (this material is being used in a new subject with a very small number of students). Material from another project was used in a practical class and simulated the 'wet' lab that it replaced.

Project Number	Replaces lectures	Used in lectures	Used in tutorials	Used in practical classes	Used for pre-lab work	Also available for other use	Not used in scheduled classes	Not used
1				•	•	•		
2				•				
3		•						
4			•			•		
5		•	•					
6							•	
7								•*
8								
9							•	
10							•	
11			•			•		
12							•	
13				•				
14	•							
15			•			•		
16					•			
17				•		•		
18				•				
19								•
20				•		•		
21							•†	
22							•	

Table 11 Use of materials developed on CAUT National Teaching Development Grants.

* Not completed. † Will be used in scheduled class time in 1997.

Effects of the National Teaching Development Grants on Students

Measuring student learning is notoriously difficult and the effects of the packages developed on student learning have not been attempted by the bulk of respondents. About two thirds of respondents (15, n=19) felt in a position to comment of changes in attitudes or approaches by students. Of these, positive effects on students of the projects were reported by most respondents. One reported effect is that there is a greater independence in learning by students and that: 'students have accepted the need to build their own skills', 'students are becoming more independent and taking more responsibility for learning rather than blaming the tutor/lecturer if they don't learn something sufficiently to pass the exam', and that: 'Students appear to learn a little more independently'. A number reported greater enthusiasm by students and that students had demonstrated: 'more involvement, self-motivation and enthusiasm'. 'Definitely a more positive attitude and enthusiasm for research and their own potential

to contribute’, ‘student reaction to the teaching materials has been positive and this may have raised interest and motivation in class’. One respondent felt that there had been changes to students as a result of *developing* materials as the students appreciated what they were trying to do, and that: ‘I feel that the software development (not necessarily the material itself) has been positive for students’. Another respondent also commented on the students appreciating the effort and attention involved in developing such materials. That students ‘enjoyed’ using the materials was stated by two respondents and that the parts of the course using TBL had scored well on the ‘feel good’ parts of course evaluations. One other commented that students are now much friendlier towards him.

On the other hand, two respondents felt that there had been little or no changes in students as a result of the National Teaching Development Grant materials or their development.

Effects of the National Teaching Development Grants on Staff

There was a wide range of perceptions about the effects of CAUT National Teaching Development Grants on other staff members, but generally it was felt the effects had been positive (n=19). Only one response to the question “Have there been any changes in other teaching staff as a result of your National Teaching Development Grant? *e.g.*, Changes in attitude, approach” suggested that there had not been a change in attitudes in other staff members. That response was: ‘Not really. I doubt we’ve convinced anyone who wasn’t already convinced...’. Most responses, however, indicated that through their grant, other members of staff had had their awareness of the use of computer aided learning raised and had shown interest in using the materials developed in their teaching or in developing CAL materials themselves. The other side of this is that in two departments other staff members have seen the intense effort and time required to develop CAL materials and that this has put them off developing materials themselves: ‘Other staff have seen how much work is required in taking on a

CAUT grant and are unlikely ever to apply for one', 'Other subjects have used some but not all of the ideas, it is a rather labour intensive way to teach'.

The effect of receiving a CAUT grant on one's career was mentioned by two respondents. One respondent, perhaps facetiously, suggested that the demonstrated commitment to teaching that a CAUT National Teaching Development Grant represented could have a negative impact on an academic's career: '...there's a degree to which holding a National Teaching Development Grant indicates an unhealthy preoccupation with teaching, which can be bad for your career :-)'.

Another respondent believed that receiving the National Teaching Development Grant had a positive effect on his career and that it was: 'Wonderful from a career point of view'. Through the awarding of the grant he was asked to speak at a number of university forums which raised his profile on campus and set him up as a local expert on teaching. Since the grant he has received a university 'Excellence in Teaching' award and a promotion, and believes both of these are linked to his success in gaining the National Teaching Development Grant. Thus through his success in getting a National Teaching Development Grant he felt that the profile of teaching in the department had been raised. Another respondent indicated that an awareness of teaching issues had been raised among fellow staff members and that: 'I think some are a little worried that there is more to this teaching than the transmission of information'.

Discussion

It appears that although CAL materials developed on CAUT National Teaching Development Grants may not themselves be having a significant impact on raising the quality of the educational experience for students, there has been a beneficial effect on the quality of education more generally through raising the awareness of teaching academics of a range of educational issues and raising teaching on the list of priorities of many universities. This is demonstrated through numerous universities introducing annual 'Excellence in Teaching' awards in the mid-1990s.

That the material itself is not having a major impact is indicated by few departments replacing classes with the materials, but rather just making it available to those students interested in using it to supplement classes. Much of the materials developed are tutorial style (instructivist approach) rather than a more innovative use of the technology, although a number of the tutorial materials also include a simulation component which indicates a constructivist approach to learning. Though computers are well-suited to instructivist tutorial materials through the self-paced nature of delivery, the infinite patience of the computer, and the immediacy of feedback, use of technology in this way does not necessarily engage students in their own education any more than a traditional (instructivist) tutorial class.

It is possible that the quality of education could be increased as the teachers' time freed up by the use of computers in this way would enable them to spend time extending talented students, or supporting students particularly challenged by the material. The reality, however, seems to be that the CAL materials developed have not, on the whole, freed up teaching time. It may also be argued that in these times of severe financial cutbacks in Australian universities that if teaching time was reduced through the use of CAL, then staff members would be given other responsibilities or staffing reduced.

That almost a third of the material developed by respondents has not been incorporated into formal class time, but rather is available as an optional extra study resource, also goes against the guidelines for applicants for the National Teaching Development Grants where in point 4.3 'The Project' of the 'Guidelines to Applicants' for 1993-5 (the years from which grantees were contacted) it is stated that: "A teaching development project eligible for funding is one which will: ... - integrate successfully into the total learning process for the relevant course of study". Although it is not stated that the materials developed should be used in class time this seems to be the implication of the above statement.

That almost half of the respondents had not been involved in the development of CAL materials before receiving their CAUT National Teaching Development Grant is not surprising due to so few people having developed CAL materials before the 1990s. What is perhaps more disturbing is that only half used the services of an instructional designer in the development of their CAL materials. This suggests perhaps that in these projects there may have been a lack of consideration of the best way the materials could be presented (including considering if TBL materials was the appropriate methodology) and merely the presentation of the traditional style of teaching on a computer.

The involvement of students in the development of a product or process that is targeted at students is perhaps an important key in determining if a project has a likelihood of enhancing the quality of the education in the sense of TQE. The involvement of students in the process of developing materials may indicate a recognition and an appreciation of the student as both consumer and colleague in the teaching and learning process. However, the involvement of students in evaluating CAUT National Teaching Development Grant materials was suggested in the 'Guidelines to Applicants' for the grants so that all groups used students for feedback is to be expected. That half of the projects used student feedback only in the final stages of development suggests that any feedback could only be used for 'fine tuning' design problems or ironing out 'bugs' rather than having a fundamental impact on the material itself.

Conclusions

From the results of this questionnaire it appears that on the whole the materials developed from the CAUT National Teaching Development Grants have not in themselves facilitated an increase in the quality of the educational experience⁷. In the vast majority of cases nor have they become a substitute for formal classes and thus

⁷ Though it is not possible that any TBL material, however brilliant, alone could do this, as will be discussed in the next chapter).

freed up the time of teaching staff to allow them to spend time with the students to facilitate a quality educational experience through more personal interactions with staff. However, through the processes involved in gaining a CAUT National Teaching Development Grant and in undertaking the project, it seems that not only have the grant recipients gained a greater appreciation and knowledge of the issues involved in teaching and learning, but that the profile of teaching and the possibility of using technology in teaching and learning has also been raised in their department. As CAUT National Teaching Development Grants have been awarded to team leaders at all Australian universities it may be surmised that the profile of teaching has thus been raised at all Australian universities.

Part of the process of applying for a CAUT National Teaching Development Grant involved not only preparing the application, which in itself would raise the applicant's awareness of other TBL materials available, and hopefully development, implementation, and evaluation issues, but it was also required that all of the applications from a university should be endorsed by the university's Vice Chancellor and ranked by the university before being forwarded to CAUT. This process was complained about by some institutions as very time consuming, in particular as the ranking by a university appeared to be ignored by CAUT in some cases (Moses and Johnson 1995). However, it appears to have been beneficial to the cause of CAUT 'to promote the development of good teaching practices in higher education' as it has raised the awareness of issues of teaching and learning of members of the university community at all levels. A wide-ranging discussion about the effectiveness of the CAUT may be found in the *Review of the Committee for the Advancement of University Teaching* (Moses and Johnson 1995).

CHAPTER 8 GENERAL DISCUSSION

Through the activities of the Committee for Quality Assurance in Higher Education (CQAHE), and primarily the substantial amount of funding it allocated, the Department of Employment, Education and Training was successful in its aim of putting the issues of Quality on the agenda of Australian universities. Through this incentive funding, quality management and practices in Australian universities have become a goal of university management in this country. This has been a successful strategy as a device for setting the agendas of the universities while (apparently) allowing them to retain their autonomy. Although the means (incentive funding) by which the federal government put TQM onto the agendas of Australian universities may be questionable, the end (TQM in the universities) should enhance our university system.

The other major initiative of DEET in the early to mid-1990s was instigated through the Committee for the Advancement of University teaching (CAUT). The National Teaching Development Grants allocated annually from 1993 to 1996 by this committee were small both in total amount (\$3.1 million to \$5.1 million a year) and individual grants rarely exceeded \$50,000. For a committee with such a relatively small budget CAUT has gone a long way in achieving its aim of advancing the quality and status of teaching in Australian universities through its activities and the grants it awarded. The success of CAUT is summed up in the Executive Summary of the 1995 review of CAUT:

The Reviewers assert that CAUT is meeting the policy objectives linked with its establishment. After only three years of operation, CAUT has made significant advances towards improving in particular the status of teaching in Australian universities. CAUT activities are focusing on improving the quality of teaching and learning and can be expected to have widespread outcomes in time ...

CAUT is seen by academic staff and the professional associations as one of the few national initiatives supported by government and the institutions which support university teaching and teachers...

(Moses and Johnson 1995, p1)

Of the 22 CAUT projects looked at briefly in this thesis, only four of the projects used a problem based learning approach — but this is encouraging. Although most of the projects used tutorial style, which is perhaps neither appropriate for tertiary education nor using the power of technology in education to its full potential, all recipients of CAUT grants and members of the teams (and hopefully to some extent other colleagues) now have a better understanding of issues relating to teaching. As a large proportion of NTDGs were addressing the use of technology in teaching and learning, the level of awareness of the issues of technology in education has also been significantly raised through the activities of the CAUT.

Conversely, funds were allocated to teams with no prior experience in developing technology based learning materials and no real guidance was given to these teams by CAUT. Many of the recipients of CAUT National Teaching Development Grants had neither experience in developing of TBL materials, nor background knowledge of the field. It seems unlikely that an applicant for an Australian Research Council grant with a similar lack of experience or knowledge of the field would be successful in receiving funding. That there were few people with experience in developing TBL materials in 1993 when the NTDG scheme started is true, however, there were people with skills in instructional design and related issues who had been

preparing materials for distance education, and there was a body of research of the field to be consulted. CAUT should have acknowledge the lack of experience and knowledge of most of the applicants for NTDGs and organised a series of workshops to inform them of issues to be considered in the development of their projects.

CAUT could have also increased the quality of the outcomes of the individual projects funded through the National Teaching Development scheme by requiring that each team had at least one member who had experience in developing teaching materials. The skills required for developing teaching materials are somewhat different to lecturing and are needed on a development team. Apart from in Education faculties, few lecturers at Australian universities have training in teaching or education and thus may not have the background knowledge of issues to be considered when developing TBL materials. Merely transferring a tutorial or lecture into software for display on a computer does not enhance the quality of education.

That the processes required to produce quality TBL materials were followed in only a few of the projects discussed here, and that few of the products are being used to replace contact time with students suggests that quality TBL materials were not the outcome for most projects. This is disappointing as the team leaders had great enthusiasm for the potential of their projects and, with greater guidance from CAUT on the development processes of TBL materials, they may have delivered better quality products.

Thus although CAUT has been successful in raising the profile of teaching in Australian universities, had funds been allocated to organising workshops to raise these issues with the project leaders much time (and money) may have been saved and the quality of many projects improved. Perhaps, however, CAUT was taking a constructivist approach and allowed each individual academic learn for her or himself the hard lessons of developing TBL materials, rather than the instructivist approach that may have been that of a workshop on these issues!

Is Technology Needed for Total Quality Education?

Just as a business wanting to achieve Total Quality Management does not need to use technology as a part of the business process, a university or a course wanting to implement Total Quality Education does not need to use technology based learning materials. Given the current capabilities of computers and related technologies there are few businesses, however small, in the developed world that do not utilise computers in the business process. Certainly it would be a very rare exception of a business trying to achieve TQM that does not make use of computers in the business process, although computers and technology in itself are not a requirement of achieving TQM. Similarly, given the current circumstances of mass education and funding reduction, universities wishing to raise the quality of the educational experience of their students — and perhaps even achieve TQE — are likely to make use of technology in their teaching processes even though technology is not a prerequisite for TQE.

The use of computers and technology in education thus far has generally not led to a quality approach to education. Much of the CAL materials currently available are little more than a transference of traditional (instructivist) teaching onto a computer screen with some (sometimes irrelevant) accompanying graphics, sounds and animations. A more encouraging aspect of the CAUT National Teaching Development Grants and the development of CAL materials in general is that an increasing number of teaching academics are reconsidering teaching and their approach to it. As was said in one response to the question referring to changes in other teaching staff as a consequence of them being awarded a CAUT National Teaching Development Grant:

I think staff are looking at the way they are teaching and seeing alternatives for the first time in years. Most of us have taught how we were taught, which is basically how it has been for 200 years (?) (sic) but the CAUT projects have allowed us to try other things. The changes in staff attitudes have been a very positive thing.

Discussion

Through the TQE approach and implementing problem based learning (potentially via computers and related technologies) the quality of education may be enhanced. Used as it has been, and largely is being, used TBL has not shown the substantial benefits predicted by its proponents. For example, in a review of the effectiveness of 101 evaluations of computer-based education at the college and university levels it was found that computer-based education increased learning outcomes relative to traditional instruction by only about 0.26 of a standard deviation (Kulik and Kulik 1986). Any perceived benefits to learning that are due to the Hawthorne Effect (where workers react to the attention they are getting from the researchers and productivity increases) is another complicator in such measurements.

Conclusions

Australian universities are under ever-increasing pressure due to the increasingly heterogeneous student population and decreased funding (on an effective full time student unit basis) over the past decade. Graduates are expected to not only have grasped the content material of their course but, quite reasonably, also to have acquired a range of other skills. These skills include: strong communication skills (written and verbal), ability to work in a team, problem solving, reasoning, and lifelong learning skills. Through the use of technology in combination with problem based learning these outcomes may be achievable. Using technology-supported problem based learning recognises that at the tertiary level students are at an advanced stage of knowledge acquisition and are learning higher order thinking skills, thus using this constructivist approach to learning is appropriate. Using technology to support such an approach to learning recognises both the ability of computers and other technologies in delivering in a cohesive unit the required text, images (still and moving), and sounds, and the power of computers to rapidly process the calculations that occur 'behind the scenes' for simulations and then illustrate the results of these calculations in a useful manner.

Thus, although neither TQM of universities is a reality in Australia yet, nor is technology in university education yet being used to a large extent either to its potential or to achieve a TQE outcome, the activities of the CQAHE and the CAUT have helped move Australian universities and Australian teaching academics in the desired direction. This could have been implemented more effectively had CAUT provided more guidance to grant applicants about the process of developing educational materials, possibly through workshops or seminars, and, perhaps, advised the inclusion of an educationalist in development team as instructional designer. These suggested improvements could have made more effective use of the enthusiasm and dedication of the academics who received National Teaching Development Grants and thus increased the likelihood of their considerable labours being translated into effective products to enhance teaching and learning.

Implementing TQM is not something that is easily achieved nor is the revamping of university courses to meet the challenges of both incoming students and demands of employers and the community. That the medical faculty of Australia's oldest, and perhaps most conservative, university has made a move of its entire course from the traditional didactic style to a computer supported, problem based learning approach suggests a very promising future for the use of technology in Australian tertiary education.

POSTSCRIPT

Fate of DEET

In March 1996 the Liberal Party was elected to govern Australia after 14 years rule under the Australian Labor Party. With the new government there were many changes made to the department that administers the higher education sector in Australia. The Department of Employment, Education and Training (DEET) was changed to the Department of Employment Education, Training and Youth Affairs (DEETYA) with the Minister for this portfolio being the Honourable Amanda Vanstone.

Fate of CAUT

The Committee for the Advancement of University Teaching was wound up with the announcement in August 1996 of the establishment of the Committee of University Teaching and Staff Development (CUTSD). The chair of the new committee was announced on October 29, 1996 as Professor Ingrid Moses (one of the reviewers of CAUT). The members of the committee are to be announced in early 1997. The fate of applications for 1997 CAUT National Teaching Development Grants is currently unknown.

Fate of CQAHE

The Committee for Quality Assurance in Higher Education was wound up in December 1995. Funding recommendations for 1996 were honoured.

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APPENDIX 1: PROJECT DESCRIPTIONS

Project 1 A key attribute demanded by employers of our students is the ability to integrate knowledge across a broad range of discipline areas. The ability cannot be acquired passively from lectures or reading alone, but rather, needs experiential learning. This is often not feasible or affordable to provide. Computer-aided learning (CAL) proves a partial solution to this problem when combined with a change in pedagogy. The purpose of this project is to build the CAL resources needed to provide experiential learning for students of agricultural and forest sciences in accompaniment with a pedagogical shift in focus from lectures to exploratory learning and the revision and expansion of the text "Agriculture in Victoria".

Project 2 The project will review computer programs that can be used for the simulation of the chemical instruments that are currently in most modern chemistry departments but are normally unavailable for general undergraduate student use. Teaching packages will be produced to incorporate suitable simulation programs into experiments which can be used to introduce students to the operation and application of selected instruments.

Project 3 An innovative visual learning system (VisChem) will be produced to prepare students for first year chemistry in any university science-based course. Mental models will be developed using interactive video simulations with maximum student control over the pace, content and learning style. A team comprising experienced chemical educators, a commercial video producer, a graphic designer, and a computer programmer will ensure the highest standard of educational integrity and technical quality. Educators will be able to edit, supplement and complement VisChem resources engendering ownership and commitment to their delivery. The flexibility of format, quality, and presentation strategy will make them effective for teaching in conventional teaching presentation, as well as in open learning environments.

Project 4 The development of self paced interactive computer based tutorials and laboratory simulations will offer equal learning opportunities for students with varying background knowledge, confidence and competence in the sciences. They will also allow flexible access to learning materials outside normal class hours and for distance education students.

Project 5 The project will develop and adapt existing resources into a library of multimedia materials relating to the structure and function, at a gross and microscopic level, of the human muscular system. A Macintosh screen-based framework will be built to access these library resources in different ways to produce a learning package on the muscular system. This package, titled MacMuscles, will improve self-directed student learning, small group tutorials and large lecture groups of up to 600 students. Our aim is to maximise the use of multimedia resources in a flexible way appropriate to such varied modes of delivery. Multimedia developed in our department will be incorporated, and commercial products tailored to meet the needs of our first-year Human Biology unit. MacMuscles could provide the basis for an Open Learning module on the anatomy and physiology of the human muscular system.

Project 6 Successful student involvement in this program will enhance students' research skills, increase their involvement in and ownership of their learning process and develop both individual and teamwork skills. To achieve this end, students will undertake a series of three carefully selected practical problems of graded complexity requiring students to undertake an investigation of the current research literature and the subsequent design and implementation of experimental protocol.

Project 7 Current methods of teaching physics are inadequate to teach large classes of widely varying abilities. To address this a comprehensive computer-based multimedia physics instructional program suitable for incorporation into all existing first year physics units is being designed. The combination of coloured high resolution images, animation, full motion video and compact disc quality audio with an interactive

user friendly computer program, results in a highly stimulating learning environment under the full control of the student.

Project 8 The proposed development of computer-simulated experiments will allow subject material to be taught in a practical and interactive manner to large classes of students minimising the need for complex apparatus, animal preparations and dangerous chemicals. Computer-simulated experiments provide an excellent compromise between expense and educational outcome.

Project 9 Competence with biochemical calculations is generally only achieved as a by-product of practical classes. Current attempts to address this involve holding intensive individual tutoring sessions. However, in order to allow students to learn the art of calculations at their own pace we aim to teach the topic with the aid of innovative computer tutorials. The computer will mimic the teaching style used by the tutor and will present the subject in an animated and dynamic manner. The computer will genuinely interact with the student and will actually seek to ascertain why a student made a particular mistake. The tutorials will be able to be manipulated and customised by the individual students themselves. In this way the classes will evolve with students' own perceptions of their abilities.

Project 10 The purpose of this project is to develop a state-of-the-art learning package which will enable students at the beginning of their course to construct effective foundation concepts in electricity. Because they are not intuitive and because students have strongly held concepts of their own for electrical phenomena those concepts are poorly understood by many students. Strategies for change leading to deep understanding (to replace algorithmic learning) have been developed here and are suitable for multimedia delivery so that students will be able to use them prior to or concurrently with their studies. This will be a prototype for further packages in subjects where abstract concepts have been developed.

Project 11 The goal of this project is to create an integrated text, computer and video based package to assist students from the physical sciences in learning the techniques of

analysis of experimental data. Ability to deal with scientific data is of paramount importance to students in the physical sciences. Materials focussing on the needs of students from the physical science is rare and so educators are forced to draw on material created for groups such as statisticians and social scientists. We propose to develop a package that is focussed on the learning needs of physical science students within appropriate data analysis contexts.

Project 12 I propose to develop a series of interactive computer tutorials for first year biology students, covering the topics cell biology, energy transformations, reproduction and genetics, development, and evolution. The tutorials seek to address several major problems: students fail to identify important connections between pieces of information; they have difficulty in understanding the structure of complex biological objects; and they struggle to understand how the form and arrangement of such objects changes in time. Working through the tutorials, students will respond to a series of questions by entering text, pointing to specific objects or moving objects around on the screen. Feedback is provided in the form of text, diagrams, colour images, sound, video and animations. A tightly structured question and answer sequence is used to lead the student from basic facts through to fundamental concepts.

Project 13 This project involved the development of software used in the teaching of second-year psychology students. The software was designed to provide students with up-to-date information about theories and experiments which normally require expensive equipment and access to very young subjects. The software was evaluated by the students as being useful, interesting, educationally valuable and enjoyable to use. This material is being integrated within the normal teaching activities of the department.

Project 14 Currently the introductory soil science course for agriculture and science students is heavily based on imparting information and the learning of facts in a surface manner. The course needs development to encourage deeper student thinking and application to problem situations. Expansion of the course from 6 to 8 units in 1995 gives the opportunity to design and employ computer-interactive tutorial sessions to

improve understanding, depth of learning, and application, in several ways: (i) Information from lectures and practicals will be presented in a new relational graphic/text format to aid deeper appreciation, revision and learning; (ii) The inter-relationship of information will be emphasised by the use of dynamic interactive models where students can change the parameters and observe the consequences; (iii) Information will be used in problem solving situations to encourage relational thinking. Here, the dynamic models will serve a double role in immediately demonstrating the effects of wrong management decisions on the soil.

Project 15 This project will provide undergraduate students with self-study materials to enhance independent learning and complement traditional lectures and laboratory practicals. We have designed and developed the first-stage of the program centred on a written booklet of 11 self-study activities. This will form a basis for the application of information technology in teaching. Trials and evaluation took place in 1992 as interactive-computer activities. Student response overwhelmingly supports the new approach. The basic framework of the software will be used to develop interactive computer-aided instruction packages applicable to all first-year biology classes and second-year plant biology.

Project 16 This project aims to improve pre-laboratory instruction for chemistry undergraduates by the development of interactive multimedia learning packages at two levels, namely first year classes where basic chemical techniques are taught, and second and third year laboratories where students frequently have to use sophisticated scientific instruments.

Project 17 This project involves the production of a computer-based multimedia package for teaching ecology at undergraduate levels. The product will be designed to enhance the development of investigations skills in ecology and biology students generally, without an increase in costs for the institution. It is a cross-faculty initiative that aims to design and produce a package that will take full advantage of the most advanced interactive multimedia technology combined with the latest trends in science

education and the most recent developments in learning theory and practice. It will exploit the combination of the conceptual power of a prediction model approach with involvement of the learner in actively constructing knowledge.

Project 18 The aims are: firstly to develop methods for improving the standard and consistency of practical class assessment through the use of computers; secondly to provide rapid feedback on performance so that students have a better opportunity to overcome difficulties; and, thirdly to improve the presentation of practical classes using both videos and interactive computer assisted learning. The ultimate objective is to offer complete practical topics at remote centres, thus allowing for expansion of distance education in science.

Project 19 This project will develop interactive multimedia materials to help beginning chemistry students to understand chemical equations and apply this understanding when balancing equations and solving problems based on equations. The materials will simulate the molecular nature of chemical reactions using dynamic graphics which provide concrete representations of processes which are abstract and unobservable and therefore difficult for students to comprehend. Students will interact with the materials so that their conceptions of the molecular basis of equations are challenged and clarified. The materials will be used by tertiary students undertaking introductory chemistry units in a range of degree courses in the biological, health and environmental sciences in lecture, tutorial and self-instructional modes.

Project 20 At the heart of a geologist's view of education is the conviction that the excitement flowing from concepts of global proportions should be inextricably linked with a sound grasp of fundamental knowledge. This project aims to develop new CAL projects in field geology, palaeontology, optical mineralogy and petroleum geology, which will be fully integrated into the tutorial and practical programs of Earth Sciences. These have different specific educational objectives, but all address the issue on integrating the teaching of basic principles and skills with the global perspective of earth and planetary dynamics.

Project 21 The development of computer learning modules to increase self-directed learning of Pathology will complement face-to face teaching. This will allow a return to small group problem-based teaching in major principles and approaches. These modules are planned to be multi-levelled to allow access to various levels of undergraduate and postgraduate information and would be expanded to interact with future modules covering other relevant subjects, such as histology and clinical medicine. They will run in either Macintosh or IBM Windows environments and with major modifications of content could be adapted to Dental or Veterinary Pathology.

Project 22 This project will develop self-directed learning modules and an associated computer-based support system for undergraduates studying physiology. The initial aims are to improve students' independent study skills, allow self- paced learning despite large enrolments, and reduce students' usage in teaching. It is intended that this approach eventually be used in other Science and Medicine courses where increasing enrolments threaten educational quality. In the modules, which replace lectures and laboratory practicals, small groups use a variety of organised resources to complete topic-specific assignments and to undertake small research projects using group members as subjects, the latter approach enabling a reduction of animal usage in physiology teaching. The support system comprises a computer bulletin board, via which students can obtain help, a booking system for staff- student meetings, and software for continuous and self- assessment.

APPENDIX 2: QUESTIONS ASKED OF CAUT NATIONAL TEACHING DEVELOPMENT GRANT RECIPIENTS

1. BACKGROUND INFORMATION

- 1) Had you developed any computer aided learning materials before applying for the National Teaching Development Grant? (Please briefly outline.)
e.g. Tutorial in life cycles for first year biology class.

2. EDUCATIONAL APPROACH

- 2a) What instructional paradigm was used in the material you developed?
e.g. Drill and practice, Didactic, Tutorial, Simulation, Information Landscape, Learning Resource, Game, Other (please describe briefly).
- 2b) Why was this approach used? Were other approaches considered?
- 2c) Did you use the assistance of an instructional designer (or similar) in the development of your project?
- 2d) In what way/s (if any) were students involved in the development of the project?

3. USE OF MATERIAL DEVELOPED WITH A CAUT NTDG

- 3a) For how long (minutes/hours) is the material developed used per year? With how many students?
e.g. One hour, once a year with 200 students.
- 3b) For which year/s has the material been used in teaching?
- 3c) How is the material incorporated into the teaching program?
e.g. Students use the package during a practical class.

4. EFFECTS OF THE NTDG

- 4a) What changes in student learning have you perceived as a result of your CAUT National Teaching Development Grant? Do you have any evidence for this?
- 4b) Have there been any other changes in students as a result of the materials?
e.g. Changes in attitude, approach.
- 4c) Have there been any changes in other teaching staff as a result of your National Teaching Development Grant?
e.g. Changes in attitude, approach.

APPENDIX 3: RESPONSES TO THE QUESTIONNAIRE

1. Background Information

1) Had you developed any computer aided learning materials before applying for the National Teaching Development Grant? (Please briefly outline.)

e.g. Tutorial in life cycles for first year biology class.

Project 1 Yes. Over a 10 year period, I had developed a wide range of CAL materials.

Project 2 Using Excel to simulate various aspects of physical chemistry.

Project 3 No.

Project 4 We had been recipients of a National Priority reserve grant through the computing centre here at Curtin which had given us the opportunity to begin to develop the XXX program. (in 1992).

Project 5 Yes, the previously-funded XXX Program.

Project 6 No.

Project 7 We had dabbled but had not the resources or time to do it properly.

Project 8 No.

Project 9 No, never (never again).

Project 10 No.

Project 11 Yes in the early eighties I published a number of papers on using computers to assist in the teaching of conceptually difficult ideas in physics, such as electric and magnetic fields. As part of these paper there were brief programs that could be entered into a computer in order to simulate electric and magnetic field lines.

Project 12 Yes. I had developed pilot versions of the tutorials funded by the grant.

Project 13 No.

Project 14 No.

Project 15 Yes - we had the XXX program done - I am sure this helped with getting the first grant.

Project 16 No.

Project 17 Yes. We had previously developed the basis of the package, aimed at years 12-17 in high school. The package at that level had won national awards and been broadly acclaimed as being innovative in the approach to education. Both researchers in the project had been involved with the previous package, XXX as the Project Manager and Instructional Designer, and XXX as one of the content experts.

Project 18 Yes, we had done some preliminary work along the lines for which we obtained the grant. That appeared to be working, hence the grant application.

Project 19 Yes but not very sophisticated ones.

Project 20 Yes, we received a XXX University Quality Teaching Grant, which funded the initial phase of CAL development within the School of XXX at XXX University.

Project 21 No.

Project 22 Yes, certain team members had a great deal of experience producing computer based tutorials in Physiology.

2. Educational Approach

2a) What instructional paradigm was used in the material you developed?

e.g. Drill and practice, Didactic, Tutorial, Simulation, Information Landscape, Learning Resource, Game, Other (please describe briefly)

Project 1 In the two CAUT projects that were funded in 1994/95 a variety of paradigms were used, but the emphasis was on a transition from instructionism to students actively constructing knowledge through self-paced study with various

simulations, games and learning resources. More than 10 different CAL resources were developed and integrated into our undergraduate programs.

Project 2 Simulation and question.

Project 3 Learning resource - the molecular animations are used in lecture presentations, and an interface is being developed to enable students to access the animations in a laboratory metaphor context

Project 4 Simulation (XXX) + Tutorial

Project 5 Firstly an animation of muscle contraction, then secondly a tutorial in which students can explore the animation and answer questions about each component.

Project 6 I don't know whether it is a learning paradigm, but I would call it co-operative, problem solving

Project 7 Didactic, Tutorial, Information, Landscape, Learning Resource. Basically it was an info/resource package with some interactivity designed for students new to Physics or as a refresher to those who had completed high school physics.

Project 8 Simulation, learning resource.

Project 9 Not sure - didn't give much thought. Showing strategies - 'analogy approach'.

Project 10 I don't use any instructional paradigm! I am a developmentalist using generative learning as a way of assisting students to regenerate their own ideas.

Project 11 Sorry, don't like the word paradigm - it sends shivers up my spine! What I tried to create was a flexible learning and teaching package that included, tutorial, simulation, modelling, project work and was context rich. The various elements could be used cooperatively or as stand alone items.

Project 12 Tutorial - ask question based either on knowledge assumed from previous lectures or on earlier sections of same tutorial, provide feedback to student's answer and then go to next question.

The first stack we developed was an attempt to be semi-interactive courseware, with some “self-test” questions thrown in for good measure. The second stack was an experiment simulator.

Project 14 We invented (?) the PARS model. P = problem-based. The problem comes first because it creates a need to know and some intrinsic motivation. The program comes with a built-in problem or the teacher can drive it by setting other problems. A = acquisition. The problem requires data to be acquired. The data are obtained by activities such as measuring the soil pH or determining the bulk density. This type of data acquisition is carried out in a mimetic field and laboratory environment. Other data are obtained from the reference material or as results from an external laboratory where the experimental techniques are beyond the scope of the course. Whatever, the student has to seek out the data and information and therefore be engaged, rather than just be given the next screen. R = reference. This is where to find information and find out how to perform an experiment or look up the meaning of something. S = synthesis. Here the student has to tie together bits of data and information and reinterpret it so that some knowledge is created.

Project 15 I don't know what some of these things mean??? I suppose ours being self-learning was a mixture of didactic, tutorial. We also used one game and some simulations.

Project 16 Information, Simulation.

Project 17 The approach of this package is an extension of the original package. XXX. The original package was very much an information landscape, with problems posed as the challenge to the user and tools to allow the user to investigate the information landscape and collect relevant information to offer solutions to the problems. The extension to the package, that represents the new component of the package developed from the CAUT grant, has been designed as an extension of the

information landscape, with a simulation of the tendering and survey research process overlaid.

Project 18 I am not familiar with educational jargon, but we used a number of approaches. I suppose the basic one was to insist that students stepped their way through the analyses in a defined way and to indicate where they made an error. They could retry as many times as they liked and we wrote help files plus ultimately they have recourse to a real person.

Project 19 Needed prompting. Parts are able to be used in lectures self directed tutorial incorporating video (chemical reactions), molecular simulations, and chemical equations. “Independent student learning”.

Project 20 Instructional approaches varied from one CAL module to another because they each dealt with different educational problems within the earth science curricula. From the list above tutorial, simulation, Information Landscape and Learning resource would best cover our educational approaches.

Project 21 Reasoning; Problem Based Learning.

Project 22 With regard specifically to the computer based material, a tutorial format was used, *i.e.*, presentation of limited amount of material followed by questions that dealt with underlying concepts (as well as straight facts), then moving on to the next level.

2b) Why was this approach used? Were other approaches considered?

Project 1 Important members of our development teams were representatives from The University of XXX’s Multimedia Education Unit who contributed expertise in educational design and evaluation. Together, we considered a range of approaches and, in the end, often used a cocktail because of the heterogeneity of preferred learning styles of our students.

Project 2 We needed to test the effectiveness of the simulation relative to direct use of a real instrument.

Project 3 I cannot design a human independent program that can draw out the appropriate ideas conveyed in each animation to suit the learners' background and needs. I am in the process of seeking assistance from XXX and his colleagues to develop an information landscape type program.

Project 4 XXX - the real lab wasn't producing the outcomes we wanted - it was time intensive and required skills which the students had not yet acquired, often the lab didn't produce good results. Many students didn't have the chemistry background to enable them to calculate osmolarity and the tutorial gave us the opportunity to work through the concept with the students.

Project 5 The animation of muscle contraction is used as a "moving overhead" in the mass lecture. I wanted students to have a chance to look at this again after the lecture and to be able to identify the various components and their role in the contraction process. The team was trying to avoid structuring the learning process for the students but rather allowing them more freedom to explore but still confining them to relevant content and level.

Project 6 Gut feeling that students needed to own the process not have it thrust upon them. No other approaches considered.

Project 7 We were developing it in 1992, before much work had been done on investigating education effectiveness, and so development was by our own experiences in teaching physics and student difficulties.

Project 8 (1) It was the way to the future; (2) To provide students with an anxiety-free milieu in which to carry out (simulated) experiments; (3) As an alternative to investing about \$300,000 in class spectrophotometers; (4) To promote cooperative learning; (5) To reinforce laboratory work.

Project 9 Because that is the way it would be taught with pencil and paper. (he has written a book on this). Using computers can build up the calculation and check understanding as you go along. (XXX). The computer does what a tutor would. Using computer was a good way to do it. A book is useful but you can't build the calculation dynamically with a book. With 350 in the class there isn't time for a tutor to take each student through the calculations. The computer package allows each student to have a 'personal tutor'.

Project 10 As a result of 15 years research into learning; all other approaches had been found wanting.

Project 11 It seemed to me it offered many more teaching and learning options and was quite different to anything that is available for learning and teaching data analysis techniques to students from the physical sciences.

Project 12 The aim was to provide a supplementary learning aid for revision and reinforcement of material previously presented in lectures and practicals rather than for primary presentation of the material. My primary aim has been to assist the students' understanding of certain fundamental concepts. I set out to make the tutorial as interactive as possible.

Project 13 We had a very flexible approach, and the project was not layed out along conventional curriculum design principles. We did what we thought was most likely to be most useful. The project had to do with evaluation of the technology, but a strong agenda for me was to kick along the development of technology at the institutional level. It was not simply an exercise in designing an educational environment. A strong factor in my own views on the design approach was contact with the TLTP PSYCLE project team early in the process, but it was more at a "suck it and see" level, than a set of formal principles.

Project 14 It seemed (and still does) like a good learning model.

Project 15 Central theme self-learning and to give instant feedback See our publications and earlier reports that I believe you have

Project 16 Students were to practise procedures and understand theory before lab classes.

Project 17 This approach was used because we believed it was the best way to develop the skills of students studying ecology for competent conclusions from survey design and data collection to be drawn. The current methods of developing skills in these processes were very much limited to a theoretical study.

Project 18 It seemed to be the most suitable and fitted with our philosophy of competence being important.

Project 19 Used a number of approaches in the tutorials. The tute incorporate different styles. Design of modules was predicated on research of students' lack of understanding. Video showed the macro level, molecular modelling showed what was happening on a molecular level and then balancing equations. Info on this was gathered from observations and formal research on student learning.

Project 20 Our approaches evolved as a consequence of formative evaluation. However, given that each CAL module was designed according to the academic who controlled the teaching of a course they were designed for, his teaching needs as he perceived them controlled CAL development to begin with. As teaching duties within our department, for the most part relate to scholarly geological expertise, approaches to teaching in general as well as for our CAUT CAL development were considered the responsibility of academic assigned on the basis of geology. expertise.

Project 21 i) "That's the way I teach so it's easy to slip into". ii) "We were going to that system (PBL) anyway" iii) A strong philosophy of CBL - make computers do what it can do rather than what other things can do. Otherwise why bother - it is too expensive and time consuming to do otherwise.

Project 22 This approach provides a more interactive feel to the module.

2c) Did you use the assistance of an instructional designer (or similar) in the development of your project?

Project 1 Most definitely! Each of our 4-5 development teams per year ('94 and '95) had an educational design and evaluation specialist. I would be concerned that projects without such a team member could end up being a waste of time otherwise.

Project 2 No.

Project 3 We used experienced multimedia interface designers for the interface.

Project 4 Yes but we had a great deal of input into the design.

Project 5 Yes, indirectly. The team functioned in this capacity.

Project 6

Project 7 Yes to a limited extent.

Project 8 Yes.

Project 9 "What is an instructional designer?" When explained briefly, said it was him.

Project 10 Our team had an educational theorist (me), an multimedia expert and a programmer.

Project 11 No.

Project 12 Yes. Three instructional designers from the Distance Education Centre at UNE assisted in the development.

Project 13 No, although I was at the time enrolled in the masters in Higher Education at UNSW, so I might have claimed some limited credentials.

Project 14 A programmer with some experience in multimedia and educational principles.

Project 15 Team effort - used a Psychologist/learning expert; educationalist as well as biologists with skills in computer programming. Team effort.

Project 16 Yes.

Project 17 Yes, a full team of designers, instructional graphic and information structuring was used. A creative team, made of these type of team members was used.

Project 18 No.

Project 19 No - but did it himself. Has done research in to learning and curriculum like stuff. Had a computer educator type person on the team, but he did the Instructional Design mainly.

Project 20 To a small extent, although this was not planned for.

Project 21 No not really. Didn't formally use Instructional Designer but respondent and colleague in the USA (who is an outstanding teacher) did the instructional design.

Project 22 No, but as stated above, certain team members had a great deal of experience producing computer based tutorials in Physiology (and have sold some of their products to other institutions).

2d) In what way/s (if any) were students involved in the development of the project?

Project 1 Although, not stated in the original applications, we ended up with students in the reference group and actually involved in the development work as well as being the recipients and contributing useful feedback that has led to ongoing refinement of the CAL resources.

Project 2 We tested the approach on volunteers in the first instance to obtain reaction and feedback.

Project 3 Evaluation of the animations only.

Project 4 In the trialing of the simulation - we didn't involve them in the planning stages.

Project 5 firstly, in the development of the bank of questions students ask about muscle contraction, and later in trials of the tutorial.

Project 6

Project 7 Through formative and summative evaluation.

Project 8 We trialed the package on students at each stage of development and responded to their feedback.

Project 9 “Not a lot”. Weren’t really involved in a formal way until the program was more or less developed. The weekly sessions for feedback and watching students use it to find areas of confusion. Could be said to be informal involvement at beginning as he had learned lessons from teaching calculation classes the traditional way.

Project 10 The programmer was a student.

Project 11 Students (who had already completed a data analysis subject) were involved in the development phase of the video and the written material. For example, the concept and script for the video was given to two senior students and they gave written (and quite candid) comments back. These comments were used to modify the concept and hence the script. Students (who were new to data analysis techniques) were also used in evaluation of the prototype materials produced. Again, feedback received helped in the modification of those materials

Project 12 Honours and postgraduate students under my supervision played an active role in various phases of the development of the tutorials. In a late stage of development I obtained feedback from the target first year students by questionnaires, observation of student use of the tutorials followed by interviews and a built in function in the program which enabled students to make comments at any stage of use.

Project 13 1) a small number were employed in one way or another. 2) the process was open to student input, which we hoped to capture, BUT, 3) the reality of the process of getting software written from scratch, after receiving funds in something like March, for evaluation by students in labs before the end of the year, meant that very little consultation occurred with anybody, let alone students.

Project 14 Testing modules all along the line.

Project 15 Some postgrads/honours students tried them out as we went along. Once draft one developed they used it and we modified following feedback from questionnaires. Questionnaires on going.

Project 16 In proofing and pre trials.

Project 17 Students were involved in the formative evaluation of the package as it developed.

Project 18 They were asked to comment on the output.

Project 19 Yeah, promised to do more than actually done. Used postgrad to gather info on up to date content info. Target students were not used as much as would have liked. Final version will be done in a few weeks and will try it out on students then modify it as required. ~~Impossible~~ Difficult (*sic*) to do as much with students due to time constraints. Wants package to be in good shape before gives to students to try. Could have looked at each section with students as went but didn't. Less than anticipated. Will modify package on basis of student feedback.

Project 20 Formative evaluation (200 students).

Project 21 Students were involved in using the program as they went. It was polished as they developed. Students were not used initially (in the design phase). *i.e.* it was designed and then students used it and modifications occurred.

Project 22 We collected extensive feedback from students on their response to the material.

3. Use of material developed with a CAUT NTDG

3a) For how long (minutes/hours) is the material developed used per year? With how many students?

e.g. One hour, once a year with 200 students.

Project 1 This varies from 2 hours per year to >10 hours on an *ad hoc* basis. Some resources are only used in formal practical classes. Others are available for use at any time as the student finds the need. The latter are automatically logged so we can study usage patterns.

Project 2

Project 3 One or more animations are used in almost every lecture I give at first, second and third year, consistent with my three 'thinking level' approach (see Web site for details - address below) - probably 63 hours in first year, 8 hours second year, and 14 hours third year. 270 first year, 55 second year, and 35 third year students.

Project 4 Up from 1 to 6-8 hours (depending on student background) for the tutorial 2 hours per semester for the lab simulation *i.e.* 2 hours with 1,000 students (labs) /year plus at least 1 hour with 1,000 students (tutorial - probably average of three hours)/year.

Project 5 One hour, once a year with 800 students, once a year with 200 students, and once with 50 students, plus students can access the material at other times.

Project 6 On and off by the students as needed. One semester each year, 2 cohorts of 30 to 50 students.

Project 7 Zero now. We have moved beyond the package which was never quite finished due to our underestimation the time and money required. However we do incorporate the lessons learnt in our development of tutorials on the Web.

Project 8 I am no longer a member of that department.

Project 9 "Difficult to tell". Available on computers in biochemistry. Not a formal part of the course. Optional to use. Some students take it home.

Project 10 This is essentially a remedial package; I guess it would take about five hours to do it thoroughly.

Project 11 Not easy to answer this because, for example, the booklet produced is used consistently for about three weeks, but you would be hard put to turn this into hours per day. But, I would say video 0.5 hr, twice a year for 180 students booklet and computer disc, three weeks, twice a year for 50 students.

Project 12 Students are free to use the programs as they see fit. Encouragement is provided but there is no compulsion. At least 50% of the class of 200 internal students and 75% of a class of 100 external students used it. Level of use was highly variable but the average was around one hour per student per year.

Project 13 At the moment, the software is used in a single 2-hour lab for 200-level students each year. It is available to students outside the lab, and a small number would use it. My view is that further development of the simulation stack (which I try to keep ticking over) could result in something that could reasonably form the basis for 2-3 labs worth (each lab=2 hours roughly with 25 students roughly) of work. There are about 180 students, but it varies from year-to-year of course.

Project 14 The potential is for 20-30 hours as a replacement of some lectures and practicals. It could be used in this way in 1997. In 1996 it has been used for about 15 hours of coursework by third year students.

Project 15 CAUT developed material gave four computer programs - 4 hours x 250 students; 1 hour x 1300 students for biology first year. Have used the material elsewhere e.g. 1 x 12 students (twice used). Some other people have obtained the programs and use them. The book that goes with the programs is used for six other activities.

Project 16 Students use the material over the year. It is designed for 12 weeks of the courses but students may use the CD any number of times and even after the particular experiment they may use it at any time for revision or clarification. There are 400 + students using it.

Project 17 The prototype package has been used with a class of 25 students in Environmental Engineering for six contact hours each year over the past two years. This will continue as an annual assignment. In addition, it is used annually in a "Field Techniques in Ecology" class for 16 students, for three contact hours each year. It is anticipated that the final version will be used in a second year class in ecology (80 students for six contact hours per year), and in third year Environmental Science (10 students for three contact hours per year).

Project 18 Hard to say. we produced many components. I would guess about ten hours per year per student. Varies from class to class. 750 in first year, 200 in second year.

Project 19 Not yet in use. Will use in 1997. if used may be 20h +-18h. with 150 students. Materials also relevant to Yr 12 chemistry students (as the material is aimed at first year uni students who have not done yr 12 chemistry).

Project 20 3-4 hours per year with 200 students (usage of different modules varies).

Project 21 1996: about 120 -130 students using the package about one hour per week for two semesters. Planned more for 1997.

Project 22 Hundreds of hours. Difficult to estimate as students use the computer based tutorials in their own time. Additionally the project involved development of computer based bulletin boards which are now used in every subject that this department (approximately 5000 students).

3b) For which year/s has the material been used in teaching?

Project 1 The more than 10 CAL resources are used from years one through four of two different four year programs in Agricultural Science and Forest Science.

Project 2 Third.

Project 3 See above (Question 3a).

Project 4 1994, 1995, 1996.

- Project 5* Two.
- Project 6* Years 2 and 3 of the B.Sc. degree.
- Project 7* As the package was not fully completed (see above) it was never used formally in teaching.
- Project 8*
- Project 9* 1996.
- Project 10* Any age, any place any time.
- Project 11* 3b First semester, second year of physics, chemistry, materials science and geology subjects.
- Project 12* First year.
- Project 13* 1993, 1994, 1995. It's being rested this year, due to staff OSP.
- Project 14* It has been used in 2nd & 3rd year.
- Project 15* Last 5.
- Project 16* 1993-present. *i.e.*, 4 years.
- Project 17* 1995 and 1996 for second Year Environmental Engineering and for second/third year Ecology. In future for second year general ecology and third year environmental science.
- Project 18* Mainly first and second year.
- Project 19* Year 1 uni (year 12 school).
- Project 20* first year, second year, third year.
- Project 21* Used in 1996 as a full scale pilot (smaller evaluation pilots in earlier years).
- Project 22* The material was primarily developed for second year but the computer based bulletin boards are now used in all years.

3c) How is the material incorporated into the teaching program?

e.g., Students use the package during a practical class.

Project 1 In some cases, such as Pasture Plants of Victoria or HyperMap, students use the software to solve set problems in a practical class. In others, such as the virtual microscope, they can use the software to revise microscope technique before a class. Some resources such as the Hyperbook-Agriculture in Victoria, are available as a reference to students on an ongoing basis and usage patterns vary according to the need generated by course activities.

Project 2 Students use the package during a practical class as a preparation to using the instruments and to minimise learning time on the instrument itself. Also to give students some theoretical background to the lab when the material hasn't been covered in the theory course.

Project 3 In lectures only at present.

Project 4 Students are introduced in their 2nd lab class and have the chance to try using the tutorial. They then have two weeks to work through the material and test their ability to undertake the necessary calculations before attending the two hour practical class (simulation) in their prac class time. We lock the lab simulation until the class but they can then come and re-do it later if they wish.

Project 5 The animation is used in a formal lecture setting, then the students attend tutorials with their lab groups and use the tutorial program.

Project 6 As a resource. They don't even have to use it.

Project 7 See above.

Project 8

Project 9 Not a formal part of teaching. Perhaps will be given out with prac manual next year.

Project 10 Quite flexible and it can be accessed directly by students if they can find it.

Project 11 Video used in lectures. Booklet used for self study, problems, examples and background to a project.

Project 12 Students to make their own schedule of use of the programs. They are available at all times on the Computer Lab teaching computers.

Project 13 Students use the package during a practical class.

Project 14 15 hours of lectures were replaced by the program in 1996.

Project 15 Weekly tutorial/self-study activity so the programs fit four of these. Students also come back in own time.

Project 16 Students use the package before a practical class in order to prepare for the class.

Project 17 Students use the package during a practical class and then develop solutions to the investigations posed in their own time through the use of their own machines or general access laboratories throughout the university.

Project 18 It is used in a variety of ways. Mainly in practical classes.

Project 19 Bits will be used in some lectures some in formal tutes and other use will be on computers students have access to. Hardware issues still to sort out on general access. Not set up yet. Scheduled classes: (to be) used in about six lectures/year; three to four tutes; plus outside use.

Project 20 Students use the modules in practical classes and in their own time.

Project 21 1996: Voluntary (students used it very willingly). They came in own time, and kept coming back. For 1997 it will be timetabled for the student. It will be scheduled in addition to currently scheduled classes. There are political difficulties in scheduling sessions.

Project 22 The material is used as a resource in self-directed learning modules, the core of which is print-based. Thus at an appropriate point in working through the module the student can choose to go off and use a computer based tutorial or ask a question via the computer based bulletin board.

4. Effects of the NTDG

4a) What changes in student learning have you perceived as a result of your CAUT National Teaching Development Grant? Do you have any evidence for this?

Project 1 The students are certainly appreciative of the effort and attention being paid to their learning resources. Those students who dislike the instructivist lecture paradigm, prefer to use and claim improved learning as a result of using the CAL resources. This varies with year to year. Disturbingly, this year students have expressed dislike of having to be active in the learning process and prefer to sit back and have lectures. Hopefully, this is anomalous. We have plenty of data, more than we have time to analyse properly, from which these conclusions are drawn.

Project 2 Difficult to say - our aim in a sense was a purely practical one in overcoming the shortage of equipment in typical chemistry instrumental laboratories.

Project 3 Yes we have evaluated the resources in comprehensive focus group studies, video taped small group work and a large questionnaire study that has just been submitted for publication.

Project 4 I think students have accepted the need to build their own skills and are quite accepting of the computer approach. We have found that the tutor has more time to give individual students and that students tend to help each other more than in the traditional class. They also discuss the concepts more than they did in the old lab class.

Project 5 As a result of the IMM developed in the department, and other self-directed activities which are being constantly incorporated, students are becoming more independent and taking greater responsibility for learning rather than blaming the tutor/lecturer if they don't learn something sufficiently to pass the exam. We are able to

emphasise collaborative learning with the help of such materials. Evidence? - better pass rates in the units, anecdotal evidence from students, but it is notoriously difficult to assess improvements in learning.

Project 6 Yes have done student evaluations and seen improvement in grades. although I have done away with exams.

Project 7

Project 8

Project 9 Can't say really. I don't think anything really. The students do their learning by doing examples in class as written things, impossible to gauge if better. Very disparate group.

Project 10 Now this is a really interesting question: students don't learn around here, they get taught. And the problem is that I expect them to do the learning - that is what generative learning means. So I have a job to do to convince them that they won't get taught but will have to teach themselves.

Project 11 Students appear to learn a little more independently - this is a consequence of the project work that forms an important element of the package. The evidence, as well as feedback from questionnaires, comes from the depth to which the students have gone into the analysis of the problems presented. I think that stems from the fact that they are presented with a rich and context relevant scientific topic to work on.

Project 12 We do not yet have any good evidence that student learning has been improved by use of the materials. Longer term evaluation methods will be required to determine this. We will use at least two such methods: longitudinal analysis over several years of student performance in examination questions that test specific concepts dealt with in the tutorials; interviews with lecturers in second year units that draw upon concepts in the tutorials to determine whether there has been any improvement in student understanding of those concepts. Nonetheless, answers to first semester

examination questions in 1996 suggest that students have a better understanding of the structure of biological objects and the dynamics of change than in previous years. Understanding of other concepts which call upon interpretative skills seemed not to have improved.

Project 13 Part of the exercise (a major part in fact) was supposed to be to evaluate learning outcomes, *etc.* It was all rather high-blown (partly as a result of me doing the Masters at UNSW at the time), with questionnaires measuring approaches to studying, self efficacy, *etc, etc.* The net result was really to convince me to avoid educational psychology at all costs in the future. The results can mostly be summarised by saying that most of the questionnaires provide rather useless data, from a learning perspective. The students in general “liked” the software, and found the lab useful, but of course there’s no way of knowing whether they learned much from it. (Of course, there’s no way of knowing that they didn’t learn lots, either.) Computer anxiety is the most important factor in the students’ evaluation of the software, and it correlates with some of the “personality” factors we measured. Anxiety was less after the lab than before it, but a lot was happening in other areas of the students’ lives as well. I still haven’t correlated attitude with exam performance, but I’ve got the data and maybe I’ll get around to it one day.

Project 14 An appreciation of the relevance of the program. Quantitative testing is yet to be implemented.

Project 15 See paper by Gleadow *et al.*.

Project 16 Students ask more appropriate and meaningful questions in the lab and appear to know what they are doing. This has been observed by many of the 56 demonstrators during the year. There have been evaluations which have looked at and compared the scores on laboratories with and without CD pre-labs and initially it appeared that there was a significant difference but I now question this. Any positive numerical difference in laboratory performance is small but the confidence building and enjoyment of students using the CD and the subsequent understanding of the purpose

of the laboratory and benefit from it is clearly observed by increased student interaction and attitudes.

Project 17 We have not yet used the package in a full program, so it is not possible to answer this question yet.

Project 18 Yes. Ability in data analysis has improved. This comes from exam performance.

Project 19 No results as not used yet. Certainly sees a change in student learning as the primary aim of the materials. Whole point of it. Will be doing a study to determine this.

Project 20 Increased understanding of the integrated nature of geological processes - student evaluation questionnaires and independent observer reports.

Project 21 Is doing a study on this. Qualitative data and some quantitative data. Can surmise from student use of the package who will have difficulty in a live clinical setting. [using the package students hypothesise, describe the problem in a nutshell, questioned interactively by computer] 'Vocalising' reasoning it can only help. The package allows them to track the paths and reasoning. *e.g.*, did they get to the right answer via the right path of reasoning or the right answer via the wrong path, *etc.*

Project 22 We surveyed student opinion of the subject into which the material was incorporated and compared this to "control subjects". The modified subject score significantly higher.

***4b) Have there been any other changes in students as a result of the materials?
e.g. Changes in attitude, approach.***

Project 1 Parallel with these developments, we established a multimedia learning laboratory. We have noticed that students are spending more time in the lab outside class hours using the various CAL resources as well as other software. A 'cyber café' feel is developing.

Project 2 Generally willing to run through the complete package even when it is not necessary to do so. We house the computers in the teaching lab so that students can go back to the program if they are having problems or we feel that they aren't in control of the situation.

Project 3 In the 'feel good' parts of the surveys we've done students have been very positive, often expressing the view that the animations gave them a new perspective on chemistry, and a new appreciation as a result.

Project 4 Answered in 4a.

Project 5 See above.

Project 6 Definitely a more positive attitude and enthusiasm for research and their own potential to contribute.

Project 7

Project 8

Project 9 Very difficult to answer as he took over class this year and there has been LOTS of changes, introducing CAL material is just one of them. No benchmark.

Project 10 Not really.

Project 11 Students appear to be transferring these skills to other areas such as to their laboratory work, judging by the reports they are writing for these labs.

Project 12 I have not detected such changes. On the other hand student reaction to the teaching materials has been positive and this may have raised interest and motivation in some cases.

Project 13 I guess I've alluded to some above. I feel like I'm doing a rather bad job of selling what we did. There were changes to students as a result of our developing the software, but they were NOT DUE TO THE SOFTWARE. The students appreciated that we were trying to do something useful, and this has had significant benefits for them and us across the last few years. The grant helped to start to create an

environment where students and academic staff have become more active in the implementation of technology development within the university. To give one example, the Psychology department was able to get infrastructure funding for a Mac laboratory (located in the central IT building), which came on line last year. This kind of development has helped to foster a more positive, and less anxiety-prone (Yes, I have got the data as a matter of fact) attitude to technology in teaching of Psychology. We've a long way to go, but I feel that the software development (not necessarily the material itself) has been positive for students.

Project 14 More involvement, self motivation and enthusiasm.

Project 15 Hard to say. I think our whole course of which this is a part is well received - better score on student questionnaires than the regular biology course. Score for programs is 4+ on a 5 point scale

Project 16 See above.

Project 17 We have not yet used the package in a full program, so it is not possible to answer this question yet.

Project 18 Can't say.

Project 19

Project 20 Less stressed because of the less dense teaching strategies made possible by CAL implementation.

Project 21 Much friendlier to respondent. Respondent was astonished at so many wanted to take part. The package allows a stress-free way of ordering their thoughts. No stress as no live patients.

Project 22 We administered Richardson's shortened version of Ramsden's "Approaches to Study" questionnaire at the beginning and end of this whole of year subject. Comparison of ASQ scores obtained by students at the beginning and end of the academic year revealed that there was no significant difference between groups of

students taking the modified subject or the traditional subjects, and that there was no significant change between scores obtained at beginning and end of the year. This was a disappointing outcome but, being realistic, it may be unreasonable to expect that one subject can produce a major, generalised change in student approaches to learning.

4c) Have there been any changes in other teaching staff as a result of your National Teaching Development Grant?

e.g., Changes in attitude, approach.

Project 1 Slowly but surely, the majority of staff, who have already gone through the transition to use multimedia to enhance instruction, are now acquiring or developing interactive CAL resources as appropriate. The few, vociferous luddites remain, but will soon disappear or be drowned out.

Project 2 Staff are slowly becoming aware that there may be some circumstances where computer aided learning may be useful - a bit of an uphill battle especially with the competition for staff time by other activities.

Project 3 Many academics and teachers have expressed the view that the resources have helped them teach particular topics, however I do not have data collected on this.

Project 4 Some positives and some negatives - the positives are that staff load has been reduced, students can get specialised help elsewhere and the time constraints on the lab have been reduced. From an admin point of view our consumables budget and technical resources for this topic have been reduced. From the negative point of view - there are some who believe that we are not giving students the lab skills (even though this was never an aim of the lab). As IMM has become more popular there are a number of problems in providing access - to the extent that in semester 1 1996 we were forced to go back to the old lab for that semester - we have resumed use of the Osmosis program in semester 2.

Project 5 I think staff are looking at the way they are teaching and seeing alternatives for the first time in years. Most of us have taught how *we* were taught.

which is basically how its been for 200 yrs (?) but the CAUT projects have allowed us to try other things. The changes in staff attitudes has been a very positive thing.

Project 6 Other subjects have used some but no all of the ideas, it is a rather labour intensive way to teach.

Project 7 As a result of our work/publications and seminars, other members of staff have a more informed attitude and many are now adopting some of the principles we learnt.

Project 8

Project 9 “That’s an interesting one”. “Wonderful from a career point of view” Referred to David Lodge books (*Nice Work, Small World*) about ‘just getting one grant that will set you up for the next one, etc). Respondent got CAUT NTDG the got promoted got Excellence in Teaching Award. Thinks all linked. Got grant - gave a seminar on ‘how to get a CAUT grant’ at Vice Chancellor’s forum. Goes on his CV. Becomes a professional talker about it. It snowballs. Has raised the teaching profile in the department. OVERALL BENEFITS OF CAUT: - the hoops you have to go through to get one benefits you - consequences of getting one (e.g. promotion, raised profile).

Project 10 I think some are a little worried that there is more to this teaching game than the transmission of information.

Project 11 Part time staff have got involved in the development. This is very good from the point of view of their personal development. Other staff have seen how much work is required in taking on a CAUT grant and are unlikely to ever apply for one.

Project 12 Several other staff members have been encouraged to develop similar materials as a result of exposure to these materials.

Project 13 Not really. I doubt that we’ve convinced anybody who wasn’t already convinced, and there’s a degree to which holding an NTDG grant indicates an unhealthy preoccupation with teaching, which can be bad for your career :-) BTW, I was the first

named grantee, and tended to control the process (rather more than perhaps I should). but there were a number of other members of staff who were named on the proposal in the first place. They remain committed and enthusiastic innovators, of course.

Project 14 The lecturer who has replaced 15 hours of lectures with the (soil science) program is not a soil scientist but he appreciates the value of it in his environmental course. It is an efficient way of giving students the basics of soil science as applied to environmental problems. Most of the staff are very conservative and see this as a fringe activity.

Project 15 Other staff interested in using computer teaching in courses.

Project 16 Many staff haven't had time to look at them themselves but have commented on changes in students following use. Some are of course innately antagonistic to any change.

Project 17 The principal change in attitude among lecturing staff in Biological Sciences has been the recognition of the benefits of problem-based learning and the relatively poor student learning that follows content-based assignments. Other teaching staff who have not used the package in their teaching have nevertheless recognised the learning potential in this approach. A subsequent CAUT-funded is currently in the development stage, and proposals for other computer-based, problem-oriented teaching tools are currently being developed in the Department of XXX.

Project 18

Project 19 Other staff have been shown materials in draft form in seminars - well received. "Growing recognition/willingness to incorporate New Technologies in the unit" He can influence this (as Head of Department). Impression is that it has helped. Uni has put some quality money into developing more units using New Technologies. His school will also be putting money in to development of CAL materials. Cannot really say of getting NTDG has been the cause of these changes.

Project 20 Some increase in interest in the use of computers in teaching.

Project 21 Initially “really pissed off” because didn’t want respondent to take time out to do development as they perceived that it would increase their own burden.

Attitudes have changed since. Now very supportive. Once they saw the program they became supportive. *e.g.*, When respondent went to the US this year to do further work on the project the department offered \$1000 support.

Project 22 There was an initial spurt of enthusiasm for the concept of replacing lectures with self-directed learning modules but as time pressures on staff have gradually increased this enthusiasm has waned.